



Phoenix Sky Harbor International Airport
PHX SKY TRAIN Stage 2
PROJECT AV10000011

PACKAGE B04

SPECIFICATIONS

**VOLUME 1 OF 2
PART ONE – DIVISIONS 01 THRU 08**

ISSUED FOR CONSTRUCTION

July 13, 2018



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16995	Commissioning of Electrical Systems	12/20/2017

END OF SECTION





SECTION 02072

GEOCOMPOSITE IN-PLACE WALL DRAIN

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for geocomposite drainage panels installed behind abutments and retaining or other walls as indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. MARV: Minimum Average Roll Value.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM D 1621-16, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - b. ASTM D 2729-17, Standard Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
 - c. ASTM D 4491/D4491M-17, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - d. ASTM D 4632/D4632M-15a, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - e. ASTM D 4716/D4632M-15a, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
 - f. ASTM D 4751-16, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - g. ASTM D 4833/D4833M-07(2013)e1, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - h. ASTM D 4873/D4873M-17, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling:
 - 1. Schedule installation of the geocomposite in-place drains to follow installation of the retaining or other wall to receive the drain.



2. To minimize potential damage and deterioration between the time geocomposite drain material is placed and the time it is covered by backfill, allow the material to be exposed to the elements a maximum of 5 days.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Adhesive.
 - 2) Drainage pipe.
 - b. Certificates:
 - 1) Geocomposite Drain Flow Rate Certificate of Compliance.
 - 2) Geocomposite Drain Materials Certificate of Compliance.
 - c. Qualification Statements:
 - 1) Qualifications and certifications of the proposed Material Testing Laboratories.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Drain manufacturer's adhesive recommendations.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Material Testing Laboratories:
 - a. To perform testing of the materials to be incorporated into the Work, and to control testing and inspections of the Work this Section, employ the services of one or more independent certified material testing laboratories having the following qualifications:
 - 1) Each Material Testing Laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 329-14a and other standards specified in individual Specification Sections.
 - 2) Each Material Testing Laboratory must be capable of performing the reviews, inspections, and testing required of them by this Contract; including but not limited to the following:



- a) Inspecting, sampling, and testing proposed materials and production as required by the Program/Project Manager for compliance with the Contract Documents.
- b) Capable of securing production samples of materials at plants or stockpiles during the course of the work, and testing the samples for compliance with the Contract Documents.
- 3) The Material Testing Laboratory must be approved by the Program/Project Manager, and must also be accepted by the local jurisdictions responsible for building inspection.
- b. Dismissal and replacement of any of these independent certified Material Testing Laboratories by the Contractor requires written notice to and the approval from the Program/Project Manager.
- c. Submit the qualifications and certifications of the proposed Material Testing Laboratories to the Program/Project Manager for approval.

B. Certifications:

- 1. Geocomposite Drain Flow Rate Certificate of Compliance:
 - a. Submit a Geocomposite Flow Rate Certificate of Compliance for the geocomposite drain certifying that the drain produces the required flow rate.
 - 1) With the Certificate of Compliance, provide a flow capability graph for the geocomposite drain showing flow rates and externally applied pressures and hydraulic gradients; and stamped with the verification of an independent testing laboratory.
 - b. Submit a Geocomposite Drain Materials Certificate of Compliance with each shipment of materials attesting that the material conforms to the specified material requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Verify that a Geocomposite Drain Materials Certificate of Compliance is included with each shipment of materials.

B. Storage and Handling Requirements:

- 1. To protect rolls of geocomposite material against moisture and ultra-violet exposure prior to placement, wrap the material using a suitable protective wrapping.
- 2. Identify, store, and handle each roll in compliance with the requirements of ASTM D4873.
 - a. If the rolls are stored outdoors, elevate the rolls, and protect them with a waterproof cover.



PART 2 PRODUCTS

2.01 MATERIALS

- A. Performance:
1. Flow Rate:
 - a. Provide geocomposite drain that at a hydraulic gradient of 1.0 produces a flow rate of at least 15 gallons per minute per foot of width.
 2. Environmental Resistance:
 - a. Provide geocomposite material resistant to chemical attack, mildew, and rot.
- B. Design Criteria
1. Provide geocomposite drain mats consisting of a manufactured core having a layer of filter fabric integrally bonded to one or both sides, and capable of maintaining a drainage void the entire height of the geocomposite drain.
 2. One side of the geocomposite drain mat must be impermeable.
 3. Provide a manufactured core consisting of one of the following:
 - a. A preformed grid of embossed plastic.
 - b. A mat of random shapes of plastic fibers.
 - c. A drainage net consisting of a uniform pattern of polymeric strands forming 2 sets of continuous flow channels.
 - d. A system of plastic pillars and interconnections forming a semigrd mat.
- C. Geocomposite Manufactured Core:
1. Thickness:
 - a. Provide a manufactured core for the geocomposite drain not less than 0.25 inch thick or more than 2 inches thick.
 2. Core Properties:
 - a. Provide a manufactured core for the geocomposite drain complying with the Minimum Average Roll Values (MARV) requirements specified in Table 02072-1.

Table 02072-1 Geocomposite Drain Manufactured Core Properties (Minimum Average Roll Values [MARV])		
Property	Test Procedure	Requirement
Minimum Compressive Strength (psi)	ASTM D1621	40
Flow rate (gallons per minute per foot of width) at 14.5 psi, hydraulic gradient 1.0,	ASTM D4716	15

**D. Geocomposite Filter Fabric:****1. Fabric Properties:**

- a. Provide filter fabric complying for the geocomposite drain with the Minimum Average Roll Values (MARV) requirements specified in Table 02072-2.

Table 02072-1 Geocomposite Drain Filter Fabric Properties (Minimum Average Roll Values [MARV])		
Property	Test Procedure	Requirement
Minimum Tensile Strength, either direction, (pounds)	ASTM D4632	110
Maximum Elongation, either direction (percent)	ASTM D4632	70
Minimum Puncture Resistance (pounds)	ASTM D4833	70
Apparent Opening Size (US Standard Sieve) ⁽¹⁾	ASTM D4751	70 - 120
1. Apparent Opening Size (AOS) requirement may be adjusted by the Program/Project Manager when less than 50% of the soil particles by weight pass a US No, 200 Sieve or when permeability (ASTM D4491) of the geotextile is equal to or less than permeability of the soil.		

2.02 ACCESSORIES**A. Adhesive:**

1. Provide an approved mastic, adhesive, or other material complying with the geocomposite drain manufacturer's recommendations.
2. Submit the geocomposite drain manufacturer's adhesive recommendations and Product Data for the adhesive to the Program/Project Manager for approval.

B. Drainage Pipe:

1. Provide perforated plastic pipe conforming to the requirements specified in ASTM D2729.
2. Submit Product Data for the drainage pipe to the Program/Project Manager for approval.

PART 3 EXECUTION**3.01 EXAMINATION****A. Verification of Conditions:**



1. Verify that there are no sharp objects which could puncture the geocomposite drain on the wall.
2. Verify that the surface of the wall is clean and dry in order that the adhesive will properly adhere.

3.02 INSTALLATION

- A. Unroll the geocomposite material, and place the material on the back of the retaining or other wall for the full length of the wall.
 1. Place the permeable fabric side facing away from the wall.
 2. For geocomposite material having core material manufactured from impermeable plastic sheeting with non-connecting corrugations, place the corrugations approximately perpendicular to the drainage collection system piping.
- B. Attach the geocomposite drain to the back of the retaining or other wall with adhesive in accordance with the manufacturer's recommendations.
- C. Geocomposite Drain Joints and Ends:
 1. At geocomposite drain joints, peel back the filter fabric from the core material, and provide a minimum fabric overlap of 3 inches.
 2. At the ends of the drainage panel, provide a 3 inch lap over the edge of the core material.
 3. If additional fabric is needed to provide overlap at joints and wraparound at edges, overlap the fabric on the geocomposite drain at least 6 inches and attach it to the geocomposite drain.
- D. Drain Pipe:
 1. To connect to the perforated pipe to the geocomposite drain, peel back fabric from the manufactured core a sufficient distance to encircle the perforated pipe between the fabric and core materials with a minimum of 3 inch fabric lap over the core material.
 2. Place the perforated pipe with the perforations down.
 3. Join the pipe sections securely with appropriate couplings and/or bands.
- E. Special Techniques:

3.03 REPAIR

- A. Filter Fabric Damage:
 1. Should the filter fabric on the geocomposite drain be torn or punctured, completely replace the damaged section; or repair the damage by covering the damaged area with a piece of filter fabric large enough to cover the damage and provide a 6-inch overlap.



3.04 PROTECTION

A. Compaction of Retaining Wall Backfill:

1. To minimize the risk of damage to the geocomposite drains, use hand operated compaction equipment to compact the backfill at retaining walls no closer than 1 foot from the geocomposite material.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	03/02/2018	N/A	1.01.A	Add "abutments and"
			1.02.B	Corrections to Reference Standards





SECTION 02220

SITE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Demolition requirements for buildings and vacant lots.
2. Restoration requirements for demolition Sites.

B. Related Requirements:

1. Section 01316 - Project Meetings.
2. Section 01325 - Progress Schedules and Reports.
3. Section 01330 - Submittal Procedures.
4. Section 01500 - Temporary Facilities and Controls.
5. Section 01571 - Temporary Erosion and Sediment Control.
6. Section 01780 - Closeout Submittals.
7. Section 02231 - Clearing and Grubbing.
8. Section 02300 – Earthwork.

1.02 REFERENCES

A. Definitions:

1. Debris: All materials generated as part of demolition activities or designated for removal as part of Site cleanup activities.
2. Combustible Gas Indicator (CGI): A device having sensors calibrated to measure the amount of a combustible gas or vapor in a given atmosphere, and used to test atmospheres for sufficient oxygen content for life support and/or the presence of combustible gases or vapors posing a potential flammability/explosion hazard.
3. Lower Explosive Limit (LEL): A lower limiting concentration of a gas or vapor in air at normal ambient temperatures that is needed for the gas or vapor to ignite and explode, expressed as a percentage of the gas or vapor in the air by volume; at gas or vapor concentrations below the LEL in air, there is not enough fuel to continue an explosion.
 - a. The concentration of the gas or vapor in air is usually given as a percentage of the LEL.
4. Underground Storage Tank (UST): As defined by the United States Environmental Protection Agency, any one or combination of tanks, including underground pipes connected thereto, which is used to contain an accumulation of regulated substances, and the volume of which



including the volume of the underground pipes connected thereto is 10 per centum or more beneath the surface of the ground.

B. References

1. American Petroleum Institute (API):
 - a. API RP 1604 - Closure of Underground Petroleum Storage Tanks.
 - b. API RP 2003 - Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents.
 - c. ANSI/API 2015 - Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks.
 - d. API 2202 - Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks.
 - e. API 2207 - Preparing Tank Bottoms for Hot Work.
 - f. API 2217A - Guidelines for Work in Inert Confined Spaces in the Petroleum Industry.
 - g. API 2219 - Safe Operation of Vacuum Trucks in Petroleum Service.
 - h. API RP 2220 - Improving Owner and Contractor Safety Performance.
2. Maricopa County:
 - a. Maricopa County Air Pollution Regulations:
 - 1) Regulation III – Control of Air Contaminants:
 - a) Rule 310 – Fugitive Dust from Dust-Generating Operations.
 - b) Rule 310.01 - Fugitive Dust from Open Areas, Vacant Lots, Unpaved Parking Lots, and Unpaved Roadways.
3. U. S. Government:
 - a. Code of Federal Regulations (CFR):
 - 1) Occupational Safety and Health Administration, Department of Labor (OSHA):
 - a) 29 CFR 1910 Occupational Health and Safety Standards.
 - b) 29 CFR 1926 Safety and Health Regulations for Construction.
 - 2) Environmental Protection Agency (EPA):
 - a) 40 CFR 60 Standards of Performance for New Stationary Sources.
 - b) 40 CFR 61 National Emission Standards for Hazardous Air Pollutants.
 - c) 40 CFR 62 Approval and Promulgation of State Plans for Designated Facilities and Pollutants.
 - d) 40 CFR 63 National Emission Standards for Hazardous Air Pollutants for Source Categories.
 - e) 40 CFR 122 EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.
 - f) 40 CFR 131 Water Quality Standards.
 - b. United States Code:
 - 1) 15 U.S.C. Section 2601 et seq.



- a) Federal Toxic Substances Control Act, Public Law 99-519, as amended.
- 2) 33 U.S.C. Section 1251 et seq.
 - a) Water Quality Act of 1987, Public Law 100-4.
 - b) Clean Water Act of 1977, Public Law 95-217.
 - c) Federal Water Pollution Control Act Amendments of 1972, Public Law 95-500.
- 3) 42 U.S.C. Section 6901 et seq.
 - a) Resource Conservation and Recovery Act (RCRA), Public Law 94-580.
- 4) 42 U.S.C. Section 7401 et seq.
 - a) Clean Air Act, as amended by Public Law 101-549, 104 Stat. 2399.95-95.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities by demolition operations.
 - a. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from the authorities having jurisdiction.
 - 1) Coordinate street and sidewalk closings and traffic control with the City of Phoenix Street Transportation Department Traffic Operations Division, the City of Phoenix Right-of-Way Management program, and with other appropriate government agencies.
 - 2) Obtain all permits required by the City of Phoenix, and pay necessary fees.
 - 3) Prepare traffic control and walkway plans required by the City of Phoenix Special Traffic Regulations.
 - b. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 1) Ensure safe passage of persons around the area of demolition.
- 2. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to schedule shut downs of utilities and services
- 3. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to disconnect, relocate, and/or provide temporary utility service connections and lines as needed if these have not been previously completed.
 - a. Coordinate all utility related work during construction activities to avoid tapping into established Aviation Facilities and Services utilities at Phoenix Sky Harbor International Airport.



- b. Forward all utility information to the Design and Construction Services Division (DCS) of the Phoenix Sky Harbor International Airport.

B. Meetings:

1. Pre-Demolition Meeting:

- a. Prior to beginning demolition operations, attend a mandatory pre-demolition meeting with the Program/Project Manager held in accordance with the requirements specified in Section 01316, Project Meetings.

2. Safety Meetings:

- a. Conduct daily safety meetings with the demolition staff.

C. Sequencing:

1. Coordinate and sequence the demolition work with the work of other trades whose activities are mutually affected to avoid conflicts, mistakes, omissions, disputes, and delays.

2. Unfinished Work:

- a. Sequence and schedule work with consideration for the stability of the areas of the structure not intended for removal or are intended for removal at a later time.
- b. Provide and secure bracing, shoring, or lateral supports to shore unstable areas created as a result of any cutting, removal, or demolition work.

D. Scheduling:

1. Show all phases of the demolition work on the Project Schedule required under Section 01325, Progress Schedules and Reports, including dates that each phase of the work will begin and end.

- a. Show the shut-off, capping, and continuation of utility services.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Tank cleaning agent.

b. Certificates:

- 1) Certificates of Destruction.

c. Special Procedure Submittals:

- 1) Underground Storage Tank Removal Work Plan (USTWP).

d. Qualification Statements:

- 1) Demolition licenses.



- 2) Resumes, licenses, or other qualifications of the personnel intended for performing tank removal operations.
- 3) Licenses, certifications, and other qualifications of the firm intended for performing utility location operations.
- 4) Name and location, licenses, certifications, and other qualifications of the firms intended for use as waste disposal or recycling facilities.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Test and Evaluation Reports:

- 1) Documentation of the sampling and analysis of materials to be removed and transported.
- 2) Records of inspections and tests required to comply with the requirements of each disposal facility.
- 3) Records of the backfill compaction.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Record Documentation:

1) Pre-Disposal Records:

- a) Names and locations of the disposal areas and facilities to be used for disposing and recycling the materials.
- b) Copies of the licenses, certifications, permits, and agreements required or issued for the disposal of materials.
- c) Equipment and methods to be used for removal and disposal operations.

2) Records of Waste Disposal Operations:

- a) Records of the disposal operation.
- b) Manifests of shipments of contaminated materials.
- c) Records of corrective actions taken to address any problems encountered during disposal operations.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. The Contractor and all Subcontractors who perform demolition activities must be properly licensed to perform the demolition work of this Contract.
 - a. Submit copies of the required licenses to the Program/Project Manager.



2. During all times that the Work is performed, the Contractor is responsible to have at least one fully competent and experienced general Superintendent at the Site to represent the Contractor in all matters.
 - a. Instructions and information given to the Contractor's general Superintendent by the Program/Project Manager is considered to have been given to the Contractor.
 - b. Whenever emergencies from whatever cause arise during the Contract, be prepared to perform all necessary work promptly to address the emergency conditions, including special efforts or adding extra work shifts to continue work beyond normal working hours.

1.06 SITE CONDITIONS

- A. Ambient Conditions:
 1. The use of explosives at the Site is prohibited.
 2. Do not use water to limit dust and dirt when it may create hazardous or objectionable conditions such as flooding and pollution.
- B. Existing Conditions:
 1. Structures to be demolished will be vacated prior to the start of the Work of this Section.
 - a. The Phoenix Sky Harbor International Airport assumes no legal responsibility for the actual condition of the structures to be demolished.
 - b. The conditions of the structures to be demolished that existed at the time of inspection for bidding purposes will be maintained by the Phoenix Sky Harbor International Airport.
 - c. Keys to the structures to be demolished will be available from the Program/Project Manager when they exist so the Contractor can review the structures.
 2. All existing underground and aboveground utilities, services, and improvements, if any, are indicated in the Contract Documents to the best of the Phoenix Sky Harbor International Airport's knowledge and belief; however, the Phoenix Sky Harbor International Airport has not verified this information by on-site verification of available as-built documentation, and the Contractor shall notify the Phoenix Sky Harbor International Airport of discrepancies discovered in the information provided in accordance with the notification and change procedures of the Contract.

1.07 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:



1. Remove each septic tank or UST and its associated surface and subsurface piping and equipment according to applicable Federal, State, and Local requirements.
 - a. Comply with the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act (RCRA), and other Federal laws and regulations listed in Article 1.02 or applicable, and with State and Local laws and regulations, applicable to septic tank and underground storage tank removal.
 - b. Furnish spill prevention countermeasure materials and control products, including plastic sheeting and absorbent materials
2. Package or containerize, label, manifest, transport, and dispose of hazardous liquid and solid wastes in accordance with the provisions of applicable Local, State and Federal laws and regulations.
 - a. Transport hazardous and non-hazardous waste in vehicles appropriately licensed, placarded, and operated by appropriately trained personnel.

B. Qualifications:

1. Tank Removal Personnel:
 - a. Only employ personnel qualified to perform underground storage tank removal operations that can demonstrate at least 5 years of experience performing removals similar to those required as the Work of this Section.
 - 1) Persons responsible for testing tank atmospheres using a combustible gas indicator (CGI) must be completely familiar with the use of the instrument and the interpretation of the instrument's readings.
 - b. Submit the resumes, licenses, and other qualifications of the personnel intended for performing tank removal operations to the Program/Project Manager for approval.
 - 1) Attach evidence that the persons responsible for CGI testing have been trained to use and read the CGI employed at the Site.
2. Off-Site Disposal Facility:
 - a. Use only properly licensed disposal facilities to handle the types of waste materials generated by the UST removals, and listed in the approved Underground Storage Tank Removal Work Plan (USTWP).
 - b. Off-Site disposal facilities must be approved by the Program/Project Manager prior to being used to receive waste materials from this Contract.
 - c. Submit the name and location, licenses, certifications, and other qualifications of disposal and recycling facility(s) intended for use for the disposal or recycling of tanks, piping, tank supports, liquid waste,



solid waste and appurtenances to the Program/Project Manager for approval.

C. Certifications:

1. Certificate of Destruction:

- a. For each tank decommissioned, and within 15 days of the tank's removal from the Site, submit a signed Certificate of Destruction to the Program/Project Manager.

D. Site Samples:

1. Waste Characterization Sampling and Analysis:

- a. To the extent required by the approved off-site disposal facility intended to receive the material from demolition of septic tanks and USTs being removed, have the Testing and Inspection Agency perform waste characterization sampling and analysis of the contaminated materials removed prior to transporting them off-site.
- b. Perform additional sampling and analysis required by others prior to transporting the potentially contaminated material.
- c. Conduct chemical sampling and analysis of the material being removed throughout the duration of removal activities.
 - 1) Sample and test the materials to determine if non-hazardous or hazardous contaminated materials disposal is required.
- d. Prepare, maintain, and submit to the Program/Project Manager documentation of the sampling and analysis, such as sample locations, rationale, chain-of-custody, test results, and similar information prior to removing tank contents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Provide the equipment, personnel, and facilities necessary and suitable to remove, load, transport, unload, and dispose of or recycle the excavated soil materials, USTs and hydraulic lifts, associated piping, cylinders, tank contents, and other items demolished under this Section.
 - a. If similar liquid wastes are compatible, they may be bulked for cost effective disposal.
2. Transport and manifest the liquids, residues, and rinsate removed to an approved disposal facility.
 - a. Have the Program/Project Manager sign the manifest prior to transporting waste rinsate to an approved disposal facility.
 - b. Secure the tanks on trucks for transportation to a storage or disposal facility with all accessible holes being plugged or capped.
 - 1) Provide one plug with a 1/8-inch vent hole, and locate this plug at the uppermost point on the tank to prevent the tank from being



subject to excessive differential pressure caused by temperature changes.

- a) Position the tank so the vent plug is on the top of the tank during subsequent transport and storage of the tank, or until the tank is punctured preparatory to disposal.

B. Storage and Handling Requirements:

1. Rinsate:

- a. Contain and label rinsate generated by septic tank, UST, pipe, and appurtenance cleaning operations.
 - 1) At a minimum, label the rinsate with the date it was generated, the location of the tank it was removed from, and the type of liquid or residue,
- b. Locate rinsate in above ground containers temporarily stored on-site away from traffic patterns as designated by the Program/Project Manager.
- c. Keep rinsate from cleaning operations separate from contaminated and uncontaminated surface runoffs, and from the tank contents.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Backfill:

1. Provide backfill material that conforms to the requirements specified in Section 02300, Earthwork.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Prior to performance of the actual work, carefully inspect the entire site and locate those objects and structures designated for demolition and removal.
 - a. Field verify the dimensions, quantity, type, material, location, means of anchorages and support, interconnection with other facilities, and other pertinent characteristics of facilities which must be removed or demolished to accommodate new facilities.
2. Locate existing exposed and buried active utilities, and determine the requirements for their protection, or their disposition with respect to the demolition work.



- a. Prior to performing excavation operations, contact Arizona 811 (formerly Arizona Blue Stake, Inc.) to verify the location or existence of buried utilities and avoid damage to the utilities.
 - 1) Arizona 811 may be contacted by telephone at (602) 659-7500.
 3. Inspect the properties identified for demolition to identify items of value which the Contractor intends to salvage or retain.
 - a. Notify the Program/Project Manager of the intent to retain or salvage items.
 - b. The Phoenix Sky Harbor International Airport reserves the right to renegotiate the Contract Price to reflect proposed salvaged or retained items.
- B. Evaluation and Assessment:
 1. Verify with the Program/Project Manager the objects to be removed and preserved.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Conduct demolition operations in a manner that prevents injury to adjacent buildings, structures, other facilities, and persons.
 - a. If public safety could be endangered during the progress of the demolition work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
 - 1) Provide warning signs, signals, and barricades conforming to requirements of Federal, State and local laws, rules, regulations, precautions, orders, and decrees.
 - b. Leave all sidewalks, curbs, pavement, and shoring of these and similar items in place and properly braced except as otherwise indicated in the Contract Drawings.
 - c. If buildings are designated to remain vacant on the Site, secure the doors, windows, and attic access at carports of those buildings in accordance with the requirements specified in Section 01500, Temporary Facilities and Controls.
 2. Maintain existing utilities indicated to remain, and protect them against damage.
 - a. Electrical:
 - 1) Disconnect or de-energize on-site electrical wiring close to or entering structures to be demolished.
 - 2) Coordinate with the local electrical utility company for necessary relocation of utilities.
 - b. Water:
 - 1) Disconnect or cap on-site water lines close to or entering structures to be demolished.



- 2) Protect existing fire control hydrants and repair damaged hydrants.
 - 3) Coordinate with the local municipality for necessary relocation of utilities.
 - c. Natural Gas:
 - 1) Disconnect or cap on-site gas lines and mains close to or entering structures to be demolished.
 - 2) Coordinate with the local gas utility company for necessary relocation of utilities.
 - d. Sanitary and Storm Sewers:
 - 1) Disconnect or cap sanitary sewers and storm drains close to or exiting structures to be demolished.
 3. Keep all active utilities in service.
 - a. Protect active utilities, improvements, and services from damage.
 - b. Take precautions to work safely around the utility corridors identified, or have the utility services temporarily disconnected.
 - c. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the authorities having jurisdiction.
 - d. During interruptions to existing utilities, provide temporary services acceptable to governing authorities.
- B. Surface Preparation:
1. Control fugitive dust by applying an adequate dust palliative, such as water, to the ground and debris in an amount sufficient to maintain dust as incidental to demolition and lot clearing operations in accordance with the requirements of the Maricopa County Air Pollution Regulations and with the requirements of other authorities having jurisdiction.
 - a. Sprinkle water, use temporary enclosures, and employ other suitable methods to limit dust and dirt rising and scattering into the air to the lowest practical level.
 2. Before beginning to excavate, place temporary erosion and sediment controls around proposed excavations in accordance with Section 01571, Temporary Erosion and Sediment Control, to eliminate erosion and sedimentation problems caused by the Work of this Section.
 3. Excavate around the septic tanks, USTs, and piping to be removed, and uncover them to facilitate their removal.
 - a. Excavate the tanks and their appurtenances in accordance with Section 02300, Earthwork.
 - 1) If the Program/Project Manager deems it necessary to do so, perform the excavation activities in phases, and complete all of the phases prior to the pre-final inspection.
 - b. Manage surface water runoff, seepage, and infiltrating groundwater.



4. Provide temporary barriers around open excavations in accordance with Section 01500, Temporary Facilities and Controls, to protect workers and the public from injuries sustained from falling into the excavations.

C. Removal:

1. Unless otherwise indicated in the Contract Documents, entirely remove all trees, palms, shrubs, and other vegetation areas in accordance with the requirements of Section 02231, Clearing and Grubbing.
 - a. When clearing lots, remove and properly dispose of sticks, roots, rubbish, and other material.
2. Remove or relocate active utilities, services, and improvements only as indicated on the Contract Drawings, as specified, or as provide by Change Order.

3.03 DEMOLITION

A. Regulatory Requirements:

1. Comply with the Laws, Codes, and Regulations pertaining to the work being performed.
 - a. All work is governed at all times by the applicable provisions of Federal Laws, including but not limited to, the following:
 - 1) Occupational Safety and Health Administration (OSHA):
 - a) Occupational Health and Safety Standards.
 - b) Safety and Health Regulations for Construction.
 - 2) Environmental Protection Agency (EPA):
 - a) National Emission Standards for Hazardous Air Pollutants.
 - b) Federal Toxic Substances Control Act.
 - c) Water Quality Act of 1987.
 - d) Clean Water Act of 1977.
 - e) Federal Water Pollution Control Act Amendments of 1972.
 - f) Resource Conservation and Recovery Act (RCRA).
 - g) Clean Air Act.
 - b. When performing utility work, observe the governing code authority and utility company rules and regulations as applicable.
 - c. During demolition activities, constructing soil berms, or other earth moving operations, comply with the Maricopa County Air Quality Permit and Dust Control requirements, particularly Rule 310 and Rule 310.01.

B. Inactive or Abandoned Utilities:

1. Coordinate all utility relocations with the Phoenix Sky Harbor International Airport and the utility company.



2. Remove, plug, or cap inactive and abandoned utilities encountered during the work and as indicated in the Contract Documents.
 - a. Cap all utilities in a location approved by the Phoenix Sky Harbor International Airport.
 - b. Use approved cap materials.
 - c. If no specific setbacks are indicated, plug or cap inactive and abandoned utilities at least 5 feet outside of new building walls or as required by local regulations.
- C. Building and Structure Demolition:
 1. Demolish buildings and structures to the extent indicated on the Contract Drawings.
 2. Unless it is indicated to remain, demolish concrete and masonry in small sections.
 - a. Break up concrete slabs on grade.
 3. Do not impose excessive loads on supporting walls, floors, or framing.
 - a. Distribute demolition equipment throughout the structure, and remove demolished materials promptly.
 4. Use hoists, derricks, cranes, or other suitable equipment to remove and lower structural framing members.
 5. Security Board-Up of Buildings:
 - a. On vacant buildings designated to remain, secure the doors, windows, and attic access at carports in accordance with the board-up requirements specified in Section 01500, Temporary Facilities and Controls.
- D. Demolition of Below-Grade Construction:
 1. Except as indicated by the Contract Documents, remove all below-grade construction and on-grade concrete slabs to 4 feet below existing grade.
 - a. Remove all below-grade underground storage tanks (USTs) and septic tanks in their entirety.
 - 1) Underground Storage Tank Removal Work Plan (USTWP):
 - a) Prepare and submit to the Program/Project Manager an Underground Storage Tank Removal Work Plan (USTWP) that describes in detail the proposed procedures for removing and properly disposing of existing underground storage tanks and contaminated soil and liquids to be removed.
 - (1) Provide a detailed sequence of operations, and a description of the methods and equipment to be used for each operation.
 - (2) Include procedures for carefully removing, testing, and disposing of solid materials and liquid wastes; and for safely conducting the Work.



- (a) Describe the proposed method for product removal from the tanks, pipelines, and ancillary equipment.
 - (b) Ensure that the procedures include health, safety, and emergency response procedures, and off-site transportation and disposal procedures.
- (3) Include the names and locations of appropriately licensed disposal facilities intended to be used for the disposal or recycling of removed tanks, piping, tank supports, liquid waste, solid waste, and appurtenances.
- (4) Base the USTWP on previous work experience and the guidance provided in this Specification Section.
- 2) Except as otherwise specified or indicated on the Contract Drawings, comply with the requirements of the API standards listed in Article 1.02.
- 3) Remove any existing water, fuel, or other fluids and residues in existing pipelines and appurtenances in a safe and proper way so that flammable, hazardous, toxic, or deleterious substance are not released into or on the land surface, waterways, or any other portion of the environment.
 - a) Furnish only explosion-proof or air-driven pumps for removing liquids and residues from existing piping and equipment.
 - (1) Bond the pump motors and suction hoses to pipe or otherwise ground these items to prevent electrostatic ignition hazards.
 - b) If vacuum trucks are furnished to remove liquids or residues from existing piping and equipment, comply with the requirements of API 2219.
 - (1) Ensure that the area the vacuum trucks operate in is free of flammable vapors.
 - (a) Locate the vacuum trucks upwind from the tanks and outside the path of probable vapor travel.
 - (2) Discharge vacuum pump exhaust gases through a hose of adequate size and length downwind of the truck and tank area.
 - c) Remove the residue on the interior of piping to the degree of cleanliness required by applicable regulations and by the requirements of the tank and piping disposal or recycling facilities.
 - (1) Steam and/or detergent solvent solutions may be used to aid in removing the residue provided they are disposed of the same as the pipe and equipment contents and they do not introduce hazardous substances.



- 4) Perform inspections to ensure that the contents of existing pipelines and appurtenances are thoroughly drained into suitable containers having the capacity and integrity to contain them for storage until their proper disposal can take place.
 - a) Take care to drain all depressions, pockets, lines, and pumps.
- 5) Disconnect system lines from compartments and equipment.
 - a) Disconnect pumps, tightly seal their outlets, and remove the pumps.
 - b) Remove meters, air eliminators, and manifold valves from the tanks and piping to be removed.
- 6) Tank Degassing:
 - a) Degas the tanks prior to and during cleaning operations, and before initiating tank demolition to temporarily free the tank atmosphere of vapor, and to reduce the flammable and/or combustible tank atmosphere to a safe working level.
 - (1) Remove flammable vapors using a method described in API 1604, except as follows:
 - (a) Do not fill tanks with water.
 - (b) If dry ice is employed, use a minimum of 1.5 pounds of dry ice per 100 gallons of tank volume.
 - (2) Vent vapors from tanks at a minimum of 12 feet above grade to avoid creating a flammable and/or combustible hazard.
 - (a) Existing vent pipes may be used for this purpose provided they are 12 feet above grade.
 - (b) If an existing vent pipe is not 12 feet above grade or above the building roof line, attach an extension pipe.
 - b) Obtain and maintain atmospheric readings of 10 percent or less of the lower explosive limit (LEL) prior to and during the tank cleaning process.
 - (1) Recognize that tanks can still become a source of flammable vapors even after the degassing procedures are followed.
 - (2) Test the tank and pipeline atmosphere regularly for flammable or combustible vapor concentrations according to API 1604 until tank demolition is complete.
 - (a) Use a properly calibrated combustible gas indicator (CGI) to determine the combustible atmosphere within the tank.
 - i. Properly calibrate combustible gas indicators according to the Manufacturer's instructions, and thoroughly check and maintain the calibration in



accordance with the Manufacturer's Specifications.

- (b) If another approved method as described in API 1604 is proposed in lieu of CGI testing, it must be in accordance with State and Local fire codes.

- 7) Tank Cleaning and Liquid Residue Removal:
 - a) Disconnect the tank and its associated piping.
 - b) Immediately following the tank degassing operation, clean the tank in accordance with the procedures in API 2015, and rinse it with a cleaning agent approved by the Program/Project Manager.
 - (1) Ensure that residues in the tanks and piping remain in the tanks and piping during removal operations.
 - (2) Submit Product Data for the cleaning agent to the Program/Project Manager for approval.
 - c) For removing liquids and residues from existing tanks, furnish only explosion-proof or air-driven pumps.
 - (1) Bond the pump motors and suction hoses to pipe or otherwise ground these items to prevent electrostatic ignition hazards.
- 8) Tank Demolition:
 - a) Demolish tanks and their associated lines in accordance with API 2202 and API 2207.
 - (1) Cap or plug all accessible holes.
 - (a) Provide a 1/8-inch vent hole in one plug to prevent the tank from being subjected to excessive differential pressure caused by temperature changes.
 - i. Keep the tank positioned with this vent plug on the top of the tank during subsequent transport and storage, or until they are punctured preparatory to disposal.
 - b) Label the tanks after demolition but prior to removal of the tank from the Site.
 - (1) Regardless of the condition of the tank, provide a warning label containing a warning against using the tank for storing certain types of refuse.
 - (2) Indicate each tank's former contents and the present vapor state, including vapor-freeing treatment.
 - (3) Provide a legend on the label similar to the following in lettering at least 2 inches high and legible:



1. Tank Has Contained [Fuel Oil] Not Vapor Free.
2. Not Suitable for Storage of Food or Liquids Intended for Human or Animal Consumption.

- c) Remove the tanks from the Site as promptly as possible, preferably on the day of tank demolition.
 - (1) If the tanks remain at the Site overnight, test them with a CGI in accordance with State and Local regulations prior to removing them.
 - (a) If the testing indicates an atmosphere in excess of 10 percent of the LEL, evacuate the Program/Project Manager's and Contractor's personnel to a safe area, except those directly engaged in reducing the combustible atmosphere.
 - i. Do not perform Work on or around the tanks until the combustible atmosphere in each tank is less than 10 percent of the LEL.
 - ii. Provide appropriate ventilation, degassing, or other safety measures to reduce the combustible atmosphere in each tank to less than 10 percent of the LEL prior to resuming Work.
- d) Reduce the tanks to scrap at a Site specifically designated for this activity, and sell or dispose of the demolished tanks as scrap.
 - (1) Do not reuse the tanks or sell the tanks for reuse.
 - (2) If it is not possible or feasible to reduce the tanks to scrap, render the tanks unfit for further use.
 - (a) Introduce a sufficient number of holes in the tanks to make their reuse impossible.
 - (b) Check the tanks with a CGI before and during this operation to prevent fire or explosive hazards.
- b. Contaminated Soil Excavation
 - 1) If during the UST removal activities, the Program/Project Manager determines that contaminated soil has been encountered, excavate the contaminated soil as specified in Section 02300, Earthwork, and as directed by the Program/Project Manager.
 - a) If the Program/Project Manager determines that excavation work must be phased, complete all phases of the excavation prior to the pre-final inspection.
- c. Contaminated Water Removal



- 1) If during UST removal activities the Program/Project Manager determines that contaminated water has been encountered in the excavations, remove the contaminated water from the excavation as directed by the Program/Project Manager
 - a) Arrange to dispose of the contaminated water off-site.
 - (1) Collect water characterization samples in accordance with the disposal or recycling facility's requirements and as directed by the Program/Project Manager.
 - b) If approved by the Program/Project Manager and Owner, arrange to treat the water at the Site prior to discharging it to the ground water or surface water as directed by the Program/Project Manager.
 - (1) Prior to discharging the treated water, perform the testing required by Local, State, and Federal regulations.
2. Backfill and compact all voids created by demolition operations.
 - a. Backfill and compact basements, footings, basement walls, and the total volume within substructures in their entirety.
 - b. Compact backfill in accordance with the requirements specified in Section 02300, Earthwork.
 - 1) The last 12 inches of backfill may not contain material larger than 3 inches in diameter.

E. Excavation and Grading:

1. Uniformly grade the final compacted surfaces so that they are primarily flat.
 - a. On Sites that are to be scraped to form soil berms around their perimeter, compact the soil at the Site, including the soil in the berms.
 - b. If formation of an 18-inch berm is required adjacent to a remaining building, provide the same gradient to ensure that no "free" water migrates to or collects at the wall faces.
2. After completing fine grading, treat the lot with water, and compact the soil to permanently stabilize the lot in accordance with Maricopa County Rule 310, Appendix C.
 - a. Alternative dust palliatives may only be used with the written approval of the City of Phoenix Office of Environmental Programs.
3. Level all parcels to finish grade to facilitate future weed cutting.

F. Salvage:

1. Except for items indicated to remain the property of the Phoenix Sky Harbor International Airport, other salvaged and demolished materials not indicated for reuse become the property of the Contractor.
 - a. The disposition of the other salvaged and demolished materials not indicated for reuse is at the Contractor's option.



2. Items salvaged by the Contractor may be removed from structures as the demolition work progresses.
 - a. Transport salvaged items away from the Site as they are removed.
 - 1) Storage or sale of the salvaged or removed items on-site is not permitted.
3. Salvaging items is not cause for claiming delay in the completion time agreed upon for completion of the Contract

G. Special Techniques:

1. Environmental Protection:
 - a. Comply with the regulations governing pollution controls.
 - b. If potentially dangerous materials, such as asbestos, lead, refrigerant, batteries, fluorescent light bulbs, storage drums, storage tanks, sumps, grease interceptors, or similar items are unexpectedly encountered, discontinue work in that immediate area, and report the conditions to the Program/Project Manager as soon as practicable.
 - 1) If on-site materials are found to contain hazardous contaminant concentrations above the Resource Conservation and Recovery Act (RCRA) disposal limit, remove and dispose of them in accordance with the RCRA and its amendments.

3.04 REPAIR / RESTORATION

- A. Restore adjacent areas to the conditions existing prior to the start of the demolition work.
- B. Use the same trade which originally constructed items that have been damaged to patch or repair these items at no increase in the Contract Price.
- C. Repair all damage to existing underground and overhead utilities, services, and improvements caused by demolition or other operations; whether or not such utilities, services, and improvements are indicated on the Contract Drawings.
 1. Commence and complete the work to repair damaged utilities as soon as practicable.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Compaction Test:
 - a. Test Procedure:
 - 1) Have the Testing and Inspection Agency use a nuclear density gauge or other approved method to measure the compaction of backfill and Site grading.



- b. Acceptance Criteria:
 - 1) Compaction achieving the minimum density specified is acceptable.
- 2. UST Testing:
 - a. Prior to proceeding with the final disposal of the tanks and other waste materials, have the Testing and Inspection Agency perform the testing required, including the following:
 - 1) Chemical sampling and analysis of contaminated materials removed during UST removal activities prior to transporting these contaminated materials off-site.
 - 2) Tests performed to comply with the requirements of each disposal facility.
 - b. Have the Testing and Inspection Agency test the compaction of the backfill placed, as specified in Section 02300, Earthwork, and submit the testing records to the Program/Project Manager for approval.
 - c. The Program/Project Manager will perform the confirmation sampling required at the completion of the UST and contaminated soil removals and Site remediation activities.
 - 1) Provide assistance to the Program/Project Manager to collect these verification samples for testing.
- B. Inspections:
 - 1. The Program/Project Manager will inspect all finished work and notify the Contractor of discrepancies and omitted work.
 - 2. Have the Testing and Inspection Agency perform the inspections required by regulatory agencies, the disposal facilities, and API standards.
- C. Non-Conforming Work
 - 1. Within 2 days of notification by the Program/Project Manager of discrepancies and/or omitted work, correct the discrepancies and perform the omitted work.

3.06 CLEANING

- A. Clean dust, dirt, and debris resulting from demolition operations from adjacent structures and improvements as directed by the Program/Project Manager.
- B. Promptly remove the tools, equipment, materials, and debris used during demolition activities from the Site upon completion of the Work of this Section.
- C. Waste Management:
 - 1. Leave the area in which the demolition work was performed clean and free of all rubbish and debris.
 - a. Do not leave debris inside substructure areas.



2. Remove debris, rubbish, and the debris from building demolition, and legally dispose of them off-site.
 - a. Transport demolition materials from demolished structures away from the Site.
3. Burning materials removed from demolished structures on the Site is not permitted.
4. Underground Storage Tank Disposal:
 - a. Follow the applicable regulatory requirements for disposing of removed underground storage tanks.
 - 1) In accordance with the Federal Resource Conservation and Recovery Act (RCRA) as amended, and local laws and regulations, manage liquid and solid wastes that have been determined to be hazardous according to the criteria set forth in those laws and regulations.
 - b. Pre-Disposal Documentation:
 - 1) Submit the following documentation for materials to be removed and disposed of to the Program/Project Manager prior to removing the materials from the Site:
 - a) The names and locations of the disposal areas and facilities to be used for disposing and recycling the materials.
 - b) Copies of the licenses, certifications, permits, and agreements required or issued for the disposal of materials.
 - c) The equipment and methods to be used for removal and disposal operations.
 - c. Dispose of or recycle the tanks, piping, tank supports, liquid waste, solid waste, and appurtenances removed only at the disposal facilities listed in the approved Underground Storage Tank Removal Work Plan (USTWP).
 - 1) Dispose of removed underground storage tanks at an approved facility immediately after demolition.
 - 2) Reduce removed tanks to scrap at a site specifically designated for this activity, and sell or otherwise dispose of the tanks as scrap.
 - a) Check the tanks with a combustible gas indicator (CGI) before and during this operation in order to prevent fire and explosive hazards.
 - 3) Under no circumstances allow the tanks to be reused or sold for reuse.
 - 4) If it is not possible or feasible to reduce the tanks to scrap, render the tanks unfit for further use by introducing a sufficient number of holes in the tanks to make their reuse impossible.
 - d. Disposal Operation Records:



- 1) Maintain records of the inspections and tests performed to comply with the requirements of each disposal facility.
- 2) Maintain detailed records of the entire disposal operation, including at a minimum the following information:
 - a) Date of disposal operation.
 - b) Tank number or identifier.
 - c) Tank capacity.
 - d) Tank dimensions.
 - e) Product stored.
 - f) Vapor purge method used.
 - g) Amounts of product and other liquid removed, including rinsate.
 - h) Disposal/recycling site of the tank and its appurtenances.
 - i) Detailed log of contact with regulatory agencies and all personnel involved in the operation.
 - j) Method used to render the tank unfit for the further use.
- 3) Following shipment of contaminated materials to a disposal facility, submit to the Program/Project Manager a copy of each manifest evidencing the delivery of removed material to an approved licensed disposal facility, chain of custody records, weigh tickets, meter recordings, delivery tickets, and receipts required or issued for the disposal of materials:
 - a) Prepare each manifest in accordance with the requirements of the applicable Federal, State, and local laws and regulations.
 - b) Each manifest must list, but is not limited to, the following information:
 - (1) Surface runoff.
 - (2) Tank contents.
 - (3) Expended cleaning liquids and rinsate.
 - (4) Structural components.
 - (5) Tanks and piping.
 - c) Maintain and submit to the Design Professional proper documentation for scrap metals recycling.
- 4) Maintain records of corrective actions taken to address any problems encountered during disposal operations.
- 5) Except as follows, within 15 calendar days of the final disposal of each tank submit the detailed records as described in Subparagraphs 3.06.C.4.a through 3.06.C.4.d for the entire disposal operation to the Program/Project Manager for information.
 - a) Submit appropriate manifests and related documents for hazardous liquid and solid wastes to the Design Professional within 2 working days of disposal.



3.07 PROTECTION

- A. Where excavation work is required during demolition operations and is incomplete, provide temporary chain link fencing as specified in Section 01500, Temporary Facilities and Controls, around the excavated areas.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 02223

REMOVAL OF PAVEMENT MARKINGS AND MARKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for removing existing pavement markings and markers from pavement, including:
 - a. Permanent preformed plastic pavement marking tape.
 - b. Raised pavement markers.
 - c. Thermoplastic markings.
 - d. Traffic paint.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 02786 - Tack Coat.
 - 4. Section 02741 - Bituminous Concrete Pavement.

1.02 REFERENCES

- A. Definitions:
 - 1. Asphalt Concrete Overlay: Plant mix asphalt concrete placed over existing asphalt concrete paving and compacted.
 - 2. Turboblasting: A blast cleaning method using high velocity steel shot directed at a surface to be cleaned in order to abrade the surface.
 - 3. Type I Preformed Plastic Pavement Marking Tape: General-purpose pavement markings intended for finished permanent striping and markings.
- B. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 1) Section 321 – Placement and Construction of Asphalt Concrete Pavement.
 - 2) Section 710 - Asphalt Concrete.
 - 2. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications for Public Works Construction:
 - 1) Section 330 – Asphalt Chip Seal.
 - 3. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 - Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 - Safety and Health Regulations for Construction.



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Depending on where the pavement markings and markers removal operation is to occur and the owner of the Right-of-Way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Street Transportation Department.
 - c. Phoenix Sky Harbor International Airport.
 - 2. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.
- B. Sequencing:
 - 1. Include provisions for traffic control during pavement markings and markers removal operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the workers and the public during removal operations.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Asphalt overlay material.
 - b. Delegated Design Submittals:
 - 1) Lead Exposure Plan, if removal of lead-based striping is required.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Required approvals depend on where the removal of pavement markings and markers is to be performed and who owns the right-of- way, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport Design and Construction Services.
 - 2. The special removal techniques specified in this Section are approved methods for the removal of traffic paint, thermoplastic markings, Type 1



(permanent) performed plastic tape, and raised pavement markers as indicated.

3. If removal of lead-based paint striping is required, use methods complying with the requirements of 29 CFR 1910 and 29 CFR 1926.
 - a. Notify employees of the Contractor, the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others on the construction Site, of the lead abatement activities and precautions necessary to avoid contamination by lead compounds.
 - b. Submit a Lead Exposure Plan to the Program/Project Manager for approval at least 48 hours prior to the start of lead-based paint striping obliteration activities.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver asphalt mixtures to the Site in accordance with the requirements of Section 02741, Bituminous Concrete Pavement.
- B. Storage and Handling Requirements:
 1. Stockpile, store, and handle aggregate in accordance with the requirements of Section 02741, Bituminous Concrete Pavement.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Bituminous Concrete Overlay:
 1. Provide asphalt overlay complying with the requirements of Section 02741, Bituminous Concrete Pavement.
 - a. Provide "Type D-1/2" asphalt concrete mix as specified in Section 710, Asphalt Concrete, of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 2. Submit Product Data for the asphalt overlay material to the Program/Project Manager for approval.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify the striping removal limits of the Contract with the Program/Project Manager before commencing the Work.
 - a. In order to match and tie into the existing striping, the striping removal limits may exceed the Contract construction limits, or new striping limits.
- B. Pre-Installation Testing:



1. If the type of paint in painted pavement markings to be removed is unknown, verify whether or not the striping paint is lead-based paint by testing samples.

C. Evaluation and Assessment:

1. The type of pavement markings existing will determine the appropriate removal methods required.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.

B. Surface Preparation:

1. If a bituminous concrete overlay is required for obliterating existing pavement markers, 48 hours prior to applying the overlay prepare the surface as follows:
 - a. Cut out and patch severely raveled and cracked areas that are depressed more than 3/4 inches from the adjoining pavement.
 - b. Fill large shrinkage cracks with asphalt sealing compound acceptable to the Program/Project Manager.
 - c. Clean the surface using a power broom.
 - d. Apply a tack coat complying with the requirements of Section 02786, Tack Coat, to the surfaces to receive the bituminous concrete overlay, and do not permit traffic to travel on the coated surface.

3.03 PAVEMENT MARKING OBLITERATIONS

A. Perform pavement marking obliterations or removals as shown on the Contract Drawings or as indicated by the Program/Project Manager.

1. Remove existing pavement markings and markers from pavement to the fullest extent possible by using one of the special techniques specified in this Article unless another method is approved by the Program/Project Manager.
 - a. Do not use a method for removing existing pavement markings that materially damages the surface or texture of the useable pavement.
 - b. Do not cover over existing pavement markings with slurry seal, black paint, or stain of any kind.
 - c. Do not use sandblasting or turboblasting within 12 feet of a lane occupied by traffic.
 - d. Do not use sandblasting, turboblasting, or bituminous concrete overlay for airside applications.

B. Special Techniques:

1. Techniques Approved for Removing or Obliterating Traffic Paint:



- a. High Pressure Water Jet:
 - 1) Use a high-pressure water jet with the proper spray nozzle and pressure to remove the pavement markings.
- b. Sandblasting:
 - 1) Sandblast the pavement to remove the pavement markings, taking care not to damage the pavement surface.
- c. Turboblasting (Steel Shot):
 - 1) Blast the pavement with steel shot to remove the pavement markings, taking care not to damage the pavement surface.
- d. Bituminous Concrete Overlay:
 - 1) Cover the pavement markings with a bituminous concrete overlay so the markings are no longer visible.
- e. Solvent Cleaning:
 - 1) Employ chemical agents to remove the pavement markings, taking care to comply with environmental regulations and to properly clean up residue.
- 2. Techniques Approved for Removing Raised Pavement Markers:
 - a. When removing raised pavement markers, remove both the marker and the adhesive pad, or the adhesive pad alone if the marker is missing.
 - b. Hammer and chisel:
 - 1) Manually remove the raised pavement markers with a hammer and chisel.
 - c. Blade:
 - 1) Use the blade on heavy equipment to dislodge and remove raised pavement markers.

3.04 REPAIR/RESTORATION

- A. Repair damage to the pavement caused by pavement marking removal by using methods acceptable to the Program/Project Manager.
 - 1. If asphalt slurry is used to repair damage caused by pavement marking removal methods, place the asphalt slurry parallel to the new direction of travel and not less than 2 feet in width.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Inspections:
 - a. The Program/Project Manager will inspect the Site to verify that required removals have been adequately performed in a timely manner, and whether incomplete obliteration of markings that could confuse motorists exists.
- B. Non-Conforming Work



1. If the Program/Project Manager discovers incomplete obliteration of pavement markings that may result in confusing travelers, remove them immediately.

3.06 CLEANING

- A. Remove sand or other material that is deposited on the pavement as a result of removing pavement markings and markers as the Work progresses.
 1. If blast cleaning is used as a method to remove pavement markings or objectionable material; immediately remove the residue, including dust, after contact between the sand and the surface being treated.
 - a. To remove the residue, use a vacuum attachment operating concurrently with the blast cleaning operation or other methods approved by the Program/Project Manager.
 - b. Do not allow sand or other material that might interfere with drainage or might constitute adverse safety conditions to traffic to accumulate.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/22017	N/A	All	First edition.
1	11/03/2017	N/A	1.02.B.1.a	Add "Placement and Construction of Asphalt Concrete Pavement".
1	11/03/2017	N/A	1.03.A.1.b	Change to "City of Phoenix Street Transportation Department."



SECTION 02224

PAVING REMOVAL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for demolition, removal, and disposal of existing paving.
- B. Related Requirements:
 - 1. Section 01555 - Traffic Control.

1.02 REFERENCE STANDARDS:

- A. City of Phoenix (COP):
 - 1. Phoenix Supplemental Standard Details for Public Works:
- B. Maricopa Association of Governments (MAG):
 - 1. MAG Uniform Standard Details for Public Works Construction:
- C. Maricopa County:
 - 1. Air Quality Department (MCAQD):
 - a. Guidance for Dust Control Permit for Application.
 - b. Application for Dust Control Permit.
 - c. Dust Control Logs.
 - 2. Maricopa County Air Pollution Control Regulations:
 - a. Regulation II – Permits and Fees:
 - 1) Rule 200 – Permit Requirements, Section 306 – Dust Control Permit, <https://www.maricopa.gov/DocumentCenter/View/5341>.
- D. State of Arizona:
 - 1. Arizona Revised Statutes (ARS):
 - a. ARS 40-360.41 through 45 - Chapter 2 Public Service Corporations Generally, Article 6.4, High Voltage Power Lines and Safety Restrictions.
- E. U. S. Government:
 - 1. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Depending on where the paving removal operation is to occur and the owner of the right-of- way, coordinate with and obtain the required



approvals from the appropriate State and municipal departments, including but not limited to, the following:

- a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport.
2. Adhere to each owner's specifications and/or permits, and comply with additional requirements of the owners, regarding the Work of this Section.
 3. If the owner of the right-of-way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of-way will be provided on the Contract Drawings.
 4. Demolition Safety:
 - a. Comply with applicable Arizona Revised Statutes (ARS), especially those regarding high voltage power lines and safety restrictions.
 - b. Sole responsibility for performing paving demolition in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.

B. Sequencing:

1. Include provisions for traffic control during paving removal operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the pavement from traffic.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Protect the demolition excavations, and the safety of workers and the public, in conformance with the requirements of Occupational Safety and Health Administration (OSHA), particularly "Subpart P – Excavations" of 29 CFR 1926, and the following:
 - a. Incomplete Street Crossings:
 - 1) At street crossings where backfill and temporary patches have not been completed during regular working hours, provide substantial steel plates to bridge across the demolished areas and accommodate traffic.
 - b. Dust Control Permit:
 - 1) In accordance with Rule 200 of the Maricopa County Air Pollution Control Regulations, a Dust Control Permit issued by the Maricopa County Air Quality Department is required for Sites where more than 0.1 acre (4356 square feet) of soil will be disturbed.
 - a) If a Dust Control Permit is required for this Contract, follow the instructions in the Maricopa County Air Quality Department's "Guidance for Dust Control Permit for Application" and file the "Application for Dust Control Permit", which requires including a Dust Control Plan with the Application, and pay the permit



fees in accordance with Maricopa County Air Pollution Control Regulation Rule 280.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
 - 2. Take measures adequate to protect existing utilities and other existing items and structures to remain.

3.02 DEMOLITION/REMOVAL

- A. Sidewalks:
 - 1. Demolish and remove sidewalks indicated for removal on the Contract Drawings as indicated on the Contract Drawings and to the distance required to maintain a 1 inch per foot maximum slope for the replaced portion of sidewalk.
- B. Driveways:
 - 1. Demolish and remove driveways indicated for removal on the Contract Drawings as indicated on the Contract Drawings and in the Standard Details appearing in the MAG Uniform Standard Details for Public Works Construction and Phoenix Supplemental Standard Details for Public Works.
 - 2. Demolish and remove existing concrete driveway curbs and gutters to the right-of way line and the new end of curb faced.
- C. Portland Cement Concrete Driveways, Curbs, Gutters, and Sidewalks:
 - 1. Demolish and remove existing Portland cement concrete driveway, curbs, gutters, and sidewalks indicated for removal on the Contract Drawings after saw cutting the paving at match lines.
 - a. Saw cut the paving to neat, vertical, true lines without damaging the adjoining surface not to be removed.
 - b. Minimum Depth of Cut: 1-1/2 inches, or 1/4 of the paving thickness, whichever is greater.
- D. Bituminous Concrete Driveways, Curbs, Gutters, and Sidewalks:
 - 1. Demolish and remove existing bituminous concrete driveways, curbs, gutters, and sidewalks indicated for removal on the Contract Drawings after cutting the paving using a device capable of making a neat, straight



and smooth cut without damaging the adjoining surface not to be removed.

- a. If only saw cutting is to be used, it will be indicated on the Contract Drawings.
- E. Remove pavements and aggregate base outside the roadway prism if indicated on the Contract Drawings.
- F. Special Techniques:
 1. Precast Safety Curbs Inside the Right-of-Way;
 - a. Unless otherwise indicated on the Contract Drawings, reset safety curbs currently existing inside the right-of-way approximately parallel to the new curb line directly opposite their existing location with their back edge on the right-of-way line.
 - 1) Salvage and stockpile other safety curbs existing inside the right-of-way on the adjacent property at a location agreeable to the property owner.

3.03 CLEANING

- A. At the completion of the paving removal operation, remove all paving removal equipment and traffic control devices furnished under this Section from the Site.
- B. Waste Management:
 1. Remove demolished paving materials from the Site to a legal disposal site unless otherwise specified, indicated on the Contract Drawings, or approved by the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2016	N/A	All	First edition.



SECTION 02231

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for selective clearing and grubbing operations, and the disposal of spoil materials.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01568 - Temporary Tree and Plant Protection.
 - 4. Section 01571 - Temporary Erosion and Sediment Control.
 - 5. Section 01725 - Field Engineering.
 - 6. Section 02300 - Earthwork.

1.02 REFERENCES

- A. Definitions:
 - 1. Clearing and Grubbing: Operations consisting of removing trees, shrubs, stumps, roots, fences not indicated to remain, and similar items indicated to be removed from the ground surface to clear designated areas within the Limits of Disturbance that are defined in the Contract Documents.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M 43, Standard Specification for Size of Aggregate for Road and Bridge Construction.
 - b. AASHTO T 85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - c. AASHTO T 104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - 2. ASTM International (ASTM):
 - a. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft·lbf/ft³ (600 kN·m/m³)).
 - 3. Maricopa County:
 - a. Maricopa County Air Pollution Regulations:
 - 1) Regulation III – Control of Air Contaminants:
 - a) Rule 310 – Fugitive Dust from Dust-Generating Operations.
 - b) Rule 310.01 - Fugitive Dust from Open Areas, Vacant Lots, Unpaved Parking Lots, and Unpaved Roadways.



4. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
 - b. Environmental Protection Agency (EPA):
 - 1) 40 CFR 61 National Emission Standards for Hazardous Air Pollutants.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate all utility related work during clearing and grubbing activities with Aviation Facilities and Services at Phoenix Sky Harbor International Airport to avoid tapping into established utilities.
 2. Forward all utility information to the Design and Construction Services Division (DCS) of the Phoenix Sky Harbor International Airport.
- B. Pre-Construction Meeting:
 1. Prior to beginning clearing and grubbing operations, attend a mandatory pre-construction meeting with the Program/Project Manager held in accordance with the requirements specified in Section 01316, Project Meetings.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Post-emergent herbicide per Subparagraph 2.01.B.1.b.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Surveyor Qualifications:
 - a. Employ the services of a Professional Surveyor registered in the State of Arizona, and having the additional qualifications as specified in Section 01725, Field Engineering.

1.06 SITE CONDITIONS

- A. Ambient Conditions:
 1. Explosives and Blasting:
 - a. Explosives and blasting are not allowed in the performance of the Work of this Section.
 2. Project Environmental Requirements:



- a. Comply with regulations governing pollution controls.
- b. Erosion Control:
 - 1) During the performance of the Work of this Section, implement erosion control measures as specified in Section 01571, Temporary Erosion and Sediment Control.
- c. Dust Control:
 - 1) Using the necessary means and methods, control dust on the Site during performance of the Work of this Section.
 - a) To prevent unnecessary spread of dust during the performance of the Work of this Section, thoroughly moisten surfaces and debris as required to prevent dust being a nuisance to the public, neighbors, and other concurrent work on the Site.
 - b) The Contractor is responsible for providing the water used for controlling dust.
 - 2) During earth moving operations, comply with the Maricopa County Air Quality Permit and Dust Control requirements, particularly Maricopa County Rule 310 and Rule 310.01.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fill Material:
 - 1. On-Site Fill Material:
 - a. Provide clean, uncontaminated fill material excavated on-site and consisting of soil or soil-gravel-cobble mixed materials that are free of topsoil, vegetation, lumber, metal, and refuse; and that are free of rock or similar hard objects larger than 6 inches in any dimension in non-structural fill areas, and 4 inches in any dimension in structural fill areas.
 - 1) Excavate material from the areas on the Site where extensive excavation will be required, and place and compact backfill in accordance with the requirements of Section 02300, Earthwork.
- B. Herbicides:
 - 1. Post-emergent herbicide:
 - a. Provide post-emergent herbicide designed for aquatic use with no restrictions on water use, specifically domestic use, after application.
 - b. Submit Product Data to the Program/Project Manager for approval.
 - c. Manufacturers:
 - 1) Dow AgroSciences LLC, Rodeo®, www.dowagro.com.
 - 2) Approved equal.



2.02 REGULATORY REQUIREMENTS

- A. Comply with the Laws, Codes, and Regulations pertaining to the work being performed.
 - 1. All work is governed at all times by the applicable provisions of Federal Laws, including but not limited to, the following:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
 - b. Environmental Protection Agency (EPA):
 - 1) 40 CFR 61 National Emission Standards for Hazardous Air Pollutants.
 - 2. During clearing and grubbing activities, comply with the Maricopa County Air Quality Permit and Dust Control requirements, particularly Rule 310 and Rule 310.01.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Prior to starting the actual clearing and grubbing work, carefully inspect the entire Site to locate the above and below grade structures, physical objects, and utilities designated to be protected or preserved as indicated in the Contract Documents.
 - 2. Locate existing exposed and buried active utilities, and determine the requirements for their protection, or their disposition with respect to the demolition work.
 - a. Prior to performing excavation operations, contact Arizona Blue Stake to verify the location or existence of buried utilities and avoid damage to the utilities.
 - 1) Arizona Blue Stake may be contacted by telephone at (602) 263-1100.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. In order to define trees and other items to be protected or preserved during clearing and grubbing activities, direct the Surveyor to stakeout the Limits of Disturbance as indicated in the approved Erosion and Sediment Control Plan specified in Section 01571, Temporary Erosion and Sediment Control, and as indicated in the Contract Documents.
 - 2. Provide temporary protection as specified in Section 01568, Temporary Tree and Plant Protection, for trees and other items to be protected or preserved during clearing and grubbing activities.



3. Minimize interference with roads, streets, walks, and other adjacent occupied or used facilities when conducting Site clearing operations.

B. Demolition/Removal:

1. Fence Removal:

- a. When a fence is partly or wholly within the Limits of Disturbance as indicated in the approved Erosion and Sediment Control Plan specified in Section 01571, Temporary Erosion and Sediment Control, is indicated to be removed in the Contract Documents, or is within the right-of-way; notify the property owner of the fence 30 days in advance of clearing and grubbing operations to remove the fence so that the fence's owner has the opportunity to make the necessary arrangements to relocate or rebuild the fence to maintain the security of the space enclosed or protected by the existing fence.
- b. If the owner of the fence fails to take the necessary steps to maintain the security of the fenced area within a reasonable amount of time, carefully remove the fence within the Limits of Disturbance or within the right-of-way, and neatly store this material on the fence owner's property adjacent to the Project area.

3.03 CLEARING AND GRUBBING

- A. In areas where embankment is to be placed, clear and grub the areas to a depth not less than 6 inches below the existing ground level.
- B. In areas that will be finish graded, clear and grub the areas to a depth not less than 8 inches below existing ground level.
- C. In areas that will be excavated, clear and grub the areas to the following depths:
 1. In areas of excavation for sidewalks: 6 inches.
 2. In areas of excavation for roadway: 18 inches.
 3. In areas of excavation for riprap and rock lining: 6 inches below the bottom of the riprap structure.
- D. Remove stumps, downed timber, logs, snags, and trees which are not designated to remain.
 1. In order to minimize damage to trees that are to remain standing, fell trees toward the center of the area being cleared.
 2. In order to avoid damage to overhead utilities and existing structures, fell trees located in close proximity to these items in sections.
 3. Remove stumps and roots, matted roots, and similar subsurface debris to the depths as specified except as follows.
 - a. In areas to be excavated and where embankment will be placed, dig out and remove stumps and roots completely.



- b. In areas other than areas to be excavated and where embankment will be placed, treat stumps which are over four inches in diameter with herbicide to prevent re-growth and leave them in place.
- 4. Backfill stump holes and other depressions caused by clearing and grubbing operations with the specified fill material in horizontal layers not exceeding 8 inches loose depth, and thoroughly compact each layer to a density of 95 percent of the maximum dry density in accordance with ASTM D 698 under building, slab, walkway, and pavement footprints, but do not compact the backfill in planting areas.
- E. When grubbing inside the drip line of trees indicated to remain, use only manual methods.
 - 1. Perform selective tree trimming and scar repair as required to preserve trees indicated to remain and protect them from damage or loss.
- F. Remove brush, undergrowth, and heavy growths of grass and weeds.
- G. Grubb or otherwise remove the natural obstructions in the soil; and remove such surface material which, in the opinion of the Program/Project Manager, is unsuitable for topsoil or backfill material.
- H. Remove surface debris and rubbish of any nature.

3.04 RE-INSTALLATION

- A. Re-install any items indicated to remain that were removed to facilitate clearing and grubbing operations.

3.05 CLEANING

- A. Waste Management:
 - 1. Debris Removal:
 - a. Remove clearing and grubbing debris accumulations generated by clearing and grubbing activities from the Site on a daily basis.
 - 1) Should the Contractor elect to continue work beyond normal working hours, do not allow clearing and grubbing debris to accumulate for more than 48 hours.
 - 2) Debris to be removed includes sawn timber, wood, brush, branches, and similar items.
 - 3) Do not bury stumps on the Site, but provide for their disposal as specified hereinafter.
 - b. Debris Disposal:
 - 1) Dispose of the debris from clearing and grubbing operations off-site in a lawful manner and at a site having current approval to conduct solid waste disposal activities.
 - 2) Burning of Spoil Materials:
 - a) On-site burning of spoil materials is not allowed.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 02237

PLANT SALVAGE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for complete salvage of plant materials.
 - 2. Requirements for the relocation, storage, and maintenance of salvaged plant materials.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AMQ: Acceptable Mortality Quantity.
- B. Definitions:
 - 1. Bottoming: Affixing the bottom material to the side boxing applied to the root ball of plant materials to minimize the loss of soil from the bottom of the root ball.
 - 2. Callus: The tissue that forms over the wounds of plants, protecting the inner tissues and causing healing.
 - 3. Landscape Establishment Period: The time required for a species of plant to acclimate itself to its transplanted location.
 - 4. Topwood: Material affixed to the top of the side boxing applied to the root ball of plant materials to minimize movement of the plant and its root system, and to reduce loss of soil, during transportation and handling.
- C. Related Requirements:
 - 1. Section 01568 - Tree and Plant Protection.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 02900 - Planting.

1.03 REFERENCES

- A. Reference Standards:
 - 1. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit,
 - 3) Dust Control Logs.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:



- a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
- 2) Regulation III – Control of Air Contaminants:
 - a) Rule 300 – Visible Emissions,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/300-0803.pdf.
 - b) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
 - c) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.
- 2. Tree Care Industry Association (TCIA)/American National Standards Institute (ANSI):
 - a. ANSI Z133.1, Safety Requirements for Arboriculture.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. The Construction Manager at Risk is responsible for the safety of the public, other contractors, and his/her crew members during the relocation operations.
- B. Sequencing:
 - 1. Coordinate the salvage and replanting of the salvaged materials with anticipated phasing and sequencing of other construction activities.
 - a. Submit methods for coordinating the plant salvage operations with other construction activities to the Program/Project Manager for approval.
 - 2. If the Phoenix Sky Harbor International Airport landscape staff cannot immediately identify the exact areas where plants are to be relocated, develop a temporary nursery or nurseries in the interim for storing the plants.
 - a. Submit methods for developing the temporary nursery or nurseries to the Program/Project Manager for approval.

1.05 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) List of pesticide materials proposed for use, and their application methods and documentation.
 - 2) Fertilizer/nutrients.
 - b. Shop Drawings:
 - 1) Boxes for plants.
 - c. Delegated Design Submittals:
 - 1) Location of the temporary holding yard for storing salvaged plants.
 - 2) Equipment proposed for removing and transporting salvaged plants.
 - 3) Methods for coordinating the plant salvage operations with other construction activities.
 - 4) Methods for developing the temporary nursery or nurseries.
 - 5) List of mechanical and hand equipment to be used to accomplish salvage and replanting operations.
 - d. Special Procedure Submittals:
 - 1) Saguaro Cacti Photo Log.
 - 2) Proposed method of measuring Saguaro cacti.
 - 3) Proposed form for the Saguaro Calibrated Measurement Log.
 - e. Qualification Statements:
 - 1) Plant Nursery Qualification Statement.
 - 2) Landscape subcontractor qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Written record of plant salvageability discussion and decisions.
 - b. Site Quality Control Submittals:
 - 1) Daily Plant Salvage Log.
 - 2) Current Saguaro Calibrated Measurement Logs upon completion of the initial measurements and after other required measurements thereafter.
 - 3) Salvaged Plant Watering Log.

1.06 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Dust Control Permit:
 - a. In accordance with Rule 200 of the Maricopa County Air Pollution Control Regulations, a Dust Control Permit issued by the Maricopa



County Air Quality Department is required for Sites where more than 0.1 acre (4356 square feet) of soil will be disturbed.

- b. If a Dust Control Permit is required for this Contract, follow the instructions in the Maricopa County Air Quality Department's "Guidance for Dust Control Permit for Application" and Section 01410, Regulatory Requirements, and file the "Application for Dust Control Permit and Dust Control Plan, and pay the permit fees in accordance with Maricopa County Air Pollution Control Regulation Rule 280.
 - 1) Comply with the requirements of the Maricopa County Dust Control Permit and air pollution control requirements, particularly Maricopa County Air Pollution Control Regulation Rules 310 and 310.01.
 - a) Rule 310 requires maintaining daily logs recording the actual implementation of control measures identified in the Dust Control Permit.
- c. Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.

B. Qualifications:

1. Offsite Plant Nursery Qualifications:

- a. Provide the services of an offsite plant nursery that specializes in, and has proven success in, transplanting the type of plant materials as required by the Contract Drawings and Specifications.
- b. Submit a Qualification Statement for the offsite plant nursery that includes the following information:
 - 1) Project list indicating past plant relocation projects.
 - 2) Clients for whom the relocation was performed.
 - 3) The types and quantities of plant materials moved.
 - 4) The mortality rate for the project.
 - 5) The time of year the work was performed.
 - 6) A narrative describing the daily operations of the job
 - 7) Include any deviations from the tree boxing method specified that may be proposed for incorporation into this Contract.
- c. The Program/Project Manager reserves the right to approve or disapprove of the offsite plant nursery based on review of the qualification statement.

2. Landscape Subcontractor Qualifications:

- a. Employ a landscape subcontractor licensed as a landscape contractor in the State of Arizona and in good standing.
- b. The licensed landscape subcontractor must have a minimum of 10 years' experience relocating native plants, palm trees and cacti similar to those shown in the Contract Drawings, and must have a proven record of successful palm, tree and saguaro transplanting and survival rate of at least 80 percent for 3 years after transplanting.



- c. Submit the landscape subcontractor qualifications to the Program/Project Manager for approval prior to initiation of any salvage operations, and include the following-written documentation:
 - 1) A list of a minimum of 5 native tree, palm tree, shrub, and saguaro salvaging projects the landscape subcontractor has satisfactorily completed, each of which involved the relocation of a minimum of 100 native trees, 25 date palms and 100 saguaros having sizes ranging from 3 to 25 feet in height.
 - a) Include the dates of the project work; the type of equipment used; a description of the project and work performed; and the name and phone number of a contact person representing the agency, company, or owner for which the work was completed.
 - 2) A written record of successful tree and saguaro transplanting demonstrating a survival rate of at least 80 percent for 3 years after transplanting.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport the materials for the Work of this Section in compliance with all State and local requirements.
 - a. Obtain all necessary permits and tags for transporting plant materials on public roadways.
 - b. Make permits and tags available to the Program/Project Manager upon request.
- B. Storage and Handling Requirements:
 - 1. Temporary Holding Yard:
 - a. Prior to commencing plant salvage work, submit the location of a temporary holding yard and the proposed equipment for removing and transporting the salvaged plants to the Program/Project Manager for approval.
 - 1) Provide a fenced and secure temporary holding yard.
 - 2) Prevent damage to the salvaged vegetation boxes by grading the temporary holding yard to prevent ponding, to promote positive drainage away from the salvaged plant materials, and to control offsite runoff.
 - a) Grade the nursery site to be level, with a slope no greater than 1 percent in any direction, and to safely retain all water within the established boundaries of the holding area.
 - 3) Use hand equipment and labor to keep the holding yard weed free.
 - a) Using chemicals or herbicides within a 6 foot radius of salvaged plant material to combat weeds is not allowed.
 - b. Temporary Irrigation System



- 1) Provide a temporary irrigation system in the salvage plant holding yard constructed using methods and materials that prevent rodents, insects, and pests from damaging and/or impeding the intent of the system's operation.
 - 2) Provide the temporary holding yard with a pressurized water source for watering plant material.
 - a) Provide a water source capable of delivering the necessary water to the salvaged plant materials that occupy the nursery and require irrigation.
 - b) Provide the water source for the life of the holding yard.
 - c) If a storage tank is provided for the purpose, it must be capable of providing sufficient water during a 24-hour period for the required irrigation without refilling based on the nursery being filled to capacity with salvaged plant materials.
 - 3) Use an automatic controller or automatic controllers to insure a regular watering schedule.
 - 4) Emitters:
 - a) Distribute emitters evenly across the surfaces of the rootballs.
 - b) If a drip irrigation system is proposed, design the system so no emitter point is capable of emitting water flows greater than 2 gallons per hour.
 - c) Large boxes may need additional emitters.
 - 5) Record the date, time, and frequency of watering for each plant in a Salvaged Plant Watering Log, and submit this log to the Program/Project Manager on a weekly basis for information.
2. Store and maintain salvaged material at the approved holding yard until it can be planted in its new location.
 - a. Provide optimum conditions for salvaged plants to overcome transplant shock and maintain viability throughout boxing and the storage period.
 - b. Plant Placement:
 - 1) In order to avoid sunburn damage, take care when plant material is placed in the holding area that the plant is placed facing the direction in which it originally grew.
 - 2) Properly orient the specified mark to the north side of the plant during placement.
 3. Do not allow lifting or replanting activities to damage or deform tree branches and canopies of salvaged trees.

1.08 SITE CONDITIONS

A. Ambient Conditions:

1. Salvage Season:

a. Trees and Shrubs:

- 1) Salvage and transport salvaged trees and shrubs to a temporary holding yard as specified between the **dates of April 1 through**



- September 30.** Salvage dates outside of this window will require Program/Project Manager prior approval.
- b. Cacti:
 - 1) Salvage and transport salvaged cacti to a temporary holding yard as specified between the dates of **April 1 through September 30.** Salvage dates outside of this window will require Program/Project Manager prior approval.
 - c. Date Palms:
 - 1) Salvage and transport salvaged cacti to a temporary holding yard as specified between the dates of April 1 through September 30. Salvage dates outside of this window will require Program/Project Manager prior approval.
2. Cactus Salvage Weather Constraints:
- a. Do not be excavate, transport, or remove cactus of any species during rainy weather conditions as determined by the Program/Project Manager.
 - b. Cactus salvage operations may resume after rain with the written approval by Program/Project Manager.
- B. Existing Conditions:
- 1. An Existing Plant Inventory and Salvage Summary appears in the Contract Drawings.
 - 2. Saguaro Cacti Photo Log:
 - a. Produce and submit a photo log of each saguaro cacti in its current location, capturing its orientation and notable scarring and/or blemishes.
 - 1) Include a caliper measurement of each saguaro taken 4 feet above finish grade with the photo log.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Boxes:
- 1. The following material specifications for construction of box sides are based on storage and transportation requirements.
 - 2. The following guidelines are for plants that are to be lifted upright as opposed to being tipped.
 - a. If plants are to be tipped, modify the materials used to withstand the additional stress of being tipped.
 - b. Box Member Standards
 - 1) One inch members: Standard 1 by 12 Number 5 pine minimum.
 - 2) Two inch members: Standard 2 by 6, or 2 by 12, economy grade minimum.
 - c. Provide Horizontal box members as follows:



- 1) Up to a 60-inch box: 1 inch members.
 - 2) Over a 60-inch box: 2 inch members.
 - d. Provide Vertical box members as follows:
 - 1) Up to a 48-inch box: 1 inch members.
 - 2) Over a 60-inch box: 2 inch members.
 3. Submit Shop Drawings of boxes to the Program/Project Manager for approval.
- B. Pesticide:
1. Provide materials approved by the governing regulatory agencies that are suitable for the identified needs.
 2. Submit a list of pesticide materials proposed for use, and their application methods and documentation.
- C. Soil Sulfur:
1. Provide agricultural dusting type of soil sulfur.
- D. Fertilizer/Nutrients:
1. Provide the following types of fertilizer/nutrients:
 - a. Slow release fertilizer:
 - 1) Provide 19/3/10 slow release fertilizer.
 - b. Nutrient replacement for salvage trees:
 - 1) Manufacturers:
 - a) PHC BioPak (Artistic Arborist 602-2638889).
 - b) Approved equal.
 - c. Organic Compost: Organic compost.
 - 1) Manufacturers:
 - a) Western Organics (602-269-5756).
 - b) Approved equal.
 2. Submit Product Data for the fertilizer/nutrients to the Program/Project Manager for approval.
- E. Plant Identification Tags:
1. Provide heavy duty vinyl identification tags or plastic tape, color coded as specified.
 2. Provide tags and/or tape that does not damage or deface the plant materials being tagged and identified.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Confine Work performed to within the Contract limits as defined by the Contract Drawings and Specifications and field verified by the Program/Project Manager.



B. Evaluation and Assessment:

1. Identification of Plants

- a. Protected plants within the Contract have been identified in the Native Plant Inventory and on the Existing Plant Inventory and Salvage Summary on the Contract Drawings.
- b. Flag all inventoried plants with plastic tape or vinyl tags to correspond to the determinations made in the plant Inventory in the following manner:
 - 1) White tape or vinyl tag – Plants to remain in place.
 - 2) Red tape or vinyl tag – Plants to be moved to another location.
 - 3) Blue tape or vinyl tag – Plants to be destroyed.
- c. Maintain the identification tags or tape for the duration of the Contract and landscape establishment period.
- d. All Date Palms to be salvaged shall be tagged in the field by the contractor with 1" plastic (vinyl) yellow colored tape. The tape shall be tied around each palm tree at a height of 5 feet from existing finish grade. Contractor shall tie the tape around the palm trunk no staples or other penetrating device will be allowed to secure the tape to the palm trunk. The Engineer shall review all tagged materials and approve of the palms slated for salvaging and relocating.

2. Investigation of Plant Salvageability:

- a. Use accepted methods and equipment to investigate conditions in the area surrounding each plant, including all utility, soil, and rock conditions.
- b. If upon this investigation a plant is found to have a decreased chance of being successfully boxed and relocated, contact the Program/Project Manager and any other parties the Owner requires, to come out and review the field conditions.
 - 1) A decision will then be made as to whether the plant will be relocated.
 - 2) Individual decisions will be made for each plant in question.
 - 3) Substitution or other possible alternatives will be discussed at this time.
 - 4) Prepare and submit a written record of plant salvageability discussion and decisions.

3. Marking Orientation:

- a. Mark all plants to be salvaged on their north side to provide proper orientation during storage and planting.
 - 1) Apply a mark and use an installation process that does not damage or deface the salvaged plant materials.
 - 2) Apply a mark that is capable of withstanding poor weather and expected working conditions without the possibility of erasure or detachment for the duration of the Contract, including the plant establishment period.

4. Shaded Plant Material:



- a. Properly document all salvaged plant material originally growing in a shaded condition and subsequently transplanted to a nursery as “shaded plant material”.
- b. Place the “shaded plant material” in a shaded area or areas in the nursery created by using screening or other methods approved by the Program/Project Manager and sized to adequately store these materials.
- c. Gradually expose salvaged material documented as shaded plant material to continual sunlight during its period in the nursery and prior to being transplanted to its final location as approved by the Program/Project Manager.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect-In-Place Limits:

- a. The Program/Project Manager may direct that areas or features on or adjacent to the Site are to be protected by fencing, flagging, or staking in accordance with Section 01568, Tree and Plant Protection.
- b. Provide the equipment, labor, and materials to define and protect such areas and features at no increase in Contract Price.
- c. Replace plant material to be salvaged that has been damaged or destroyed during pre-construction and construction activities with like-kind and size plant material as approved in advance by the Program/Project Manager and at no increase in Contract Price.
- d. The acceptable mortality quantity (AMQ) for each species as indicated in Subparagraph 3.06.A.2.c.1 for replacements applies to all plant materials identified as salvageable.

B. Surface Preparation:

1. The Construction Manager at Risk is responsible for safety considerations of the public, the Program/Project Manager’s personnel, and the Construction Manager at Risk’s crew during relocation operations.
 - a. Provide barricades as necessary during salvage operations to insure the safety of the public, other trades, and the salvage crew.
 - b. Follow the safety requirements of ANSI Z133.1.

3.03 SALVAGE OPERATIONS

- A. Prior to commencement of the plant salvage Work, submit a list of mechanical and hand equipment to be used to accomplish removing, transporting, and replanting salvaged plants to the Program/Project Manager for approval.
- B. Calibrated Measurements of Saguaro Cacti:
 1. Saguaro Cacti to be transplanted must have several calibrated measurements performed, the first measurement performed shall be taken



before the cactus is dug with the location of the measurement recorded and marked so that subsequent measurements can be taken at the exact same location. The next measurement performed on the saguaro cacti shall be one (1) week after the cactus is planted or moved into the temporary nursery location, and additional measurements on the saguaro shall be performed every four (4) weeks during Saguaro storage in the nursery. A measurement shall be taken at time of replanting the Saguaro in its final location and then every 4 months after that point during the remainder of the Contract Time.

- a. No additional calibration of trees will be required by the Construction Manager at Risk's landscape subcontractor.
2. Perform calibrated measurements of Saguaro cacti using methods and tools approved by the Program/Project Manager.
 - a. Use a method that allows the original points of measurement to be located easily and with pinpoint accuracy when future measurements are to be made throughout the duration of the Contract.
 - b. The minimum acceptable measurable distance of displacement between the original points of measurement and all future measurements is 1/8 inch.
 - c. Submit the proposed method of measuring Saguaro cacti to the Program/Project Manager for approval.
3. Saguaro Calibrated Measurement Log:
 - a. Keep a record of the Saguaro calibrated measurements, dates, saguaro identification number, corresponding photograph(s), final transplanted location by station and offset, and a remarks column in a written Saguaro Calibrated Measurement Log kept on file at the Site.
 - b. Submit the proposed form for recording the information in the Saguaro Calibrated Measurement Log to the Program/Project Manager for approval prior to beginning salvage of the Saguaro cacti.
 - c. Submit copies of the current Saguaro Calibrated Measurement Log to the Program/Project Manager upon completion of the initial measurements, and monthly thereafter throughout the duration of the Work of this Section and the landscape establishment period to document the other required measurements.

C. Watering:

1. Provide adequate water to each plant during digging operations to maintain its optimum health.
2. Saguaro cactus shall **NOT** be watered for a period of fourteen (14) days following their initial removal to allow the rooting system to heal.

D. Pruning:

1. Prune plants as needed; and hand dig, box, and relocate them to a temporary holding yard as specified.



2. Prune plants to be relocated in a way that removes an amount of foliage proportionate to the root system that will be eliminated by the salvage operations.
 - a. Prune plants so that an aesthetic framework of branches is left which preserves the size and best features of the plant so the plant will fill in for a balanced appearance.
 - b. Use current standards for arboriculture.
3. Remove dead and diseased branches at the direction of the Program/Project Manager.
4. For cacti, apply a one-time application of soil sulfur to all areas where branches/arms are removed.
 - a. Treat the wounds and/or cuts made to the roots and salvaged plant materials with powdered sulfur and bactericide on the same day that the cut and/or wound is made.
 - b. Make cuts so damage to the cambium layer of the tree and exposed weakness are minimized.
5. Carefully plan the excavation and root selection process for salvaged materials to ensure that the remaining roots will supply a structurally sound foundation.
 - a. Saguaro Roots:
 - 1) To achieve the proper Saguaro root length, do not commence excavation closer than three (3) feet from the trunk of each plant.
 - 2) When making the final cuts to Saguaro roots less than 1 inch in diameter, ensure each attached root has a minimum length of 12-14 inches from the buttress of the trunk or lateral support root.
 - 3) When making the final cuts to Saguaro roots greater than 1 inch but less than 3 inches in diameter, ensure each attached root has a minimum length of 16-18 inches from the buttress of the trunk or lateral support root.
 - 4) When making the final cuts to Saguaro roots greater than 3 inches in diameter, ensure each attached root has a minimum length of 24 inches from the buttress of the trunk or lateral support root.
 - b. Root length requirements stated herein are the minimum requirements and additional root length will increase survivability.
6. After pruning, employ a Certified Pesticide Applicator to apply an approved dusting of a fungicide (soil sulfur), an antibiotic (streptomycin) to the root cuts to prevent damage by wood borers and to increase moisture retention of the foliage.
 - a. Reapply granular soil sulfur and pesticide treatment 3 weeks after the initial application around the base of each saguaro.
7. Palm Tree Preparation:
 - a. After tagging of the palms, contractor shall remove all thatch and older fronds and cut back all resulting stems to within 2 inches of the base of the palm trunk. The use of chain type saws for pruning of fronds and or the removal of thatch is not allowed. The crown of the palm



shall be reduced in size per standard nursery practice with enough live fronds remaining to wrap and protect the palm crown bud.

- b. After thatch removal, the contractor shall use soft sisal rope (organic twine) to tie up all remaining fronds to protect the interior crown bud. Do not permit fronds to become damaged by means of restraint.
- c. All trunks shall be "shovel cut" for uniform appearance.
- d. Contractor shall exercise extreme caution while pruning palms to prevent the spread of vascular diseases. Contractor shall dip pruning tools in a sterilizing agent that has been approved in advance by the Engineer before beginning pruning and before moving from one palm to another.

E. Excavating Plant Materials:

1. Use only non-mechanized methods for the excavation of plants to be salvaged.
2. Saw roots off at the edge of the rootball with a sharp pruning saw and immediately treat each cut with a dusting of soil sulfur.
3. Excavate the rootball to be rectilinear, widest at the top and tapering toward the bottom in accordance with the industry standard.
4. The size of the palm tree root ball taken shall be a minimum of 3 feet by 3 feet by 4 feet, unless otherwise directed by the Engineer.

F. Boxing Plant Materials:

1. Hand dig and box plants as necessary, as indicated by Contract Drawings and Specifications, and as directed by the Program/Project Manager.
2. Water plants as needed depending on the season or as otherwise instructed by the Program/Project Manager.
3. Box/Root Ball Size:
 - a. Determine the box size as follows:
 - 1) Choose box sizes that will maximize the chances of survival for the roots but that are within economic constraints.
 - 2) Base box sizes for trees/shrubs on Table 02237-1.

Table 02237-1 Box Sizes for Trees/Shrubs	
Trunk Caliper (Inches)	Box Size (Inches)
0 to 2-1/2	24
2 to 3-1/2	30
3 to 5	36
5 to 7	42
6-1/2 to 9-1/2	48
8-1/2 - 11	54



Table 02237-1 Box Sizes for Trees/Shrubs	
Trunk Caliper (Inches)	Box Size (Inches)
11 to 13	60
12 to 15	66
14 to 17	72
16 to 20	78

- b. Indicate the box size on flagging tape attached to the plant.
 - 1) Label the caliper of the tree and the identification (ID) number corresponding to the tag on the tree on the box itself.
- c. Side Boxing:
 - 1) Provide side boxing consisting of 4 tapered box sides that enclose and preserve a rectilinear root ball, while exposing the top and bottom of the root ball with minimum damage to the root system.
 - 2) Secure the box sides with horizontal banding.
 - a) Provide 3/4-inch wide steel strip banding with a minimum thickness of 0.025 inch.
 - 3) Pack dirt tightly into any space between the box sides and the root ball.
 - 4) Water thoroughly and repack dirt as needed.
- d. Topwood:
 - 1) Place topwood so it minimizes the movement of the plant and its root system, and reduces loss of soil.
 - 2) Securely anchor topwood to the box.
- e. Bottoming:
 - 1) Leave plants side boxed for a minimum of 2 weeks and a maximum of 3 weeks, prior to bottoming.
 - 2) Bottom each plant after cutting the remaining roots, minimizing the loss of soil from the bottom of the root ball.
4. Special Protection for Saguaros:
 - a. Saguaros 7 feet in height and taller require bracing and protection capable of reasonably eliminating harmful twisting and bending of the Saguaro's trunk and/or arms during each removal and transportation.
 - 1) Use methods and/or materials that do not damage and/or mar the surface or internal structure of each saguaro.
 - 2) Use Styrofoam and/or similar materials to support saguaro arms 3 feet or longer.
 - b. Submit to the Program/Project Manager the materials and methods required to appropriately brace, protect, remove, and transport salvaged saguaros for approval.



G. Removing and Transporting Salvaged Plants:

1. Before salvaged plants can be transplanting to the indicated new locations or locations designated by the Program/Project Manager, the condition of the plant materials must be reviewed by the Program/Project Manager.
 - a. In order for the condition of the salvaged plants can be reviewed, notify the Program/Project Manager prior to transplanting each salvaged plant to the indicated new locations.
2. Remove and transport salvaged plants to the approved temporary holding yard without damaging the plant or box.
 - a. Take care so that branches are not broken or otherwise damaged by equipment or while transporting the plant materials.

H. Palm Tree Loading & Unloading:

1. A lattice type crane, or telescoping type crane or a specially designed tree crane will be acceptable for lifting and off-loading palm trees.
2. For transporting the palms from their original site to the designated and approved holding yard, the trailer used shall be long enough to avoid damage to the heart of the palm that would be caused by lack of support.
3. Loading and unloading of palms must be accomplished with the aid of nylon or fabric sling/straps with a minimum width of 4 inches. Palms should be carefully lifted off the truck setting the choker to the outside so to turn the palm to the inside as it is lifted. Extreme caution must be used to ensure that the heads are not caught, pulled on banged into or shaken; which can damage the bud.
4. Excessive scarring or trunk damage will not be permitted and will be cause for rejection of the palms.

I. Palm Tree Protection

1. Palms should be stored for no more than 48 hours in a shaded area until planting or prior to placement in a temporary planting area until such time as the ultimate area for these palms is prepared and ready for planting. During storage when laying stored the total palm surface and root ball shall be misted every three hours. When planted in a temporary holding pit or trench palms shall be watered to maintain a healthy vigorous palm.
2. Contractor is totally responsible for the palm tree's health and survivability from the initiation of the contract until the end of the landscape establishment period.
3. Palms will not be allowed to be stored on any asphalt surface.
4. The Palm trees shall be stored under a temporary shade cloth or shade structure. The materials used to create the shade must allow for air movement so that heat does not build up under the covering. The use of plastic or rubberized tarpons will not be allowed.
5. Palm tree stacking shall not be allowed the contractor shall lay palms in a single layer on a flat surface. If the palm trees are stored for more than a day, the root balls must be covered with a burlap tarp and kept moist.



6. Prolonged palm planting delays may result in rejection of the palm and replacement of like kind and size by the contractor shall be required if the delay results in rejected palm trees. The replacement shall be at no cost to the department.
7. Contractor shall apply the fungicide chemical treatment "Subdue" or approved equal as often as is recommended by the manufacturer instructions until the end of the landscape establishment phase of work.

3.04 REPAIR/RESTORATION

- A. Replace and/or repair, in kind, any plant material, geological, natural or manmade features disturbed or destroyed within or outside the limits of the Contract which were to be protected during transplanting operations.
- B. Repair damaged areas to their previous condition to the satisfaction of the Program/Project Manager.
- C. Fill-in and compact all pits left from removal of salvaged plants or as directed by the Program/Project Manager.
- D. Temporary Holding Yard:
 1. At the completion of salvage and replanting efforts and activities, remove the temporary holding yard and the associated equipment as directed by the Program/Project Manager.
 - a. Remove temporary fences, tanks, and other equipment used during the holding yard operation.
 - b. Re-grade the temporary holding yard site to return it to its pre-construction conditions, including replacing ground plane treatment provided to be in compliance with Maricopa County Dust Control measures.
 - 1) Contractor shall provide one of the following to the area occupied and considered part of the temporary holding yard as directed by the Program/Project Manager:
 - a) Two (2) inch layer of decomposed granite
 - b) Preapproved soil stabilization product
 - c) The re-establishment of native seed or ground cover to the area
 2. Prior to restoring the temporary holding yard to its pre-construction conditions, submit the proposed methods for performing this work to the Program/Project Manager for approval.



3.05 REPLANTING

- A. For replanting, follow the requirements set out in the relevant specification for each plant type in accordance with the requirements specified in Section 02900, Planting.
- B. Replant salvaged materials approximately at their original growing depth, but not more than 2 inches deeper than their original growing depth. Note this depth variation does NOT apply to Saguaro cactus that must be planted at their original planting depth.
- C. For salvaged materials transplanted deeper than their original growing depth, the root collars must be in a callused condition, and replanting will require advanced approval from the Program/Project Manager. This does not apply to Saguaro cactus.
- D. Replant saguaro and barrel cacti in the same solar orientation, at the exact same depth marked prior to excavation, and as near as possible to their vertical growth habit, found prior to their initial removal and transport.
- E. Apply a thorough application of agricultural streptomycin bactericide and powdered sulfur to the roots of each salvaged plant prior to planting.
 - 1. Plant salvaged plant materials treated with both soil sulfur and streptomycin bactericide in dry site soil at its temporary and final locations.
 - 2. Keep the surrounding soil dry for a minimum period of fourteen (14) days after application of the bactericide or powdered sulfur.
 - 3. To increase the stability of the installed plants, the Program/Project Manager may allow the plants (with the exception being the Saguaro cacti) to be watered within a few days of planting to compact the backfill.

3.06 SITE QUALITY CONTROL

- A. Inspections:
 - 1. Daily Plant Salvage Log:
 - a. Keep a daily log of all plant salvage related activities on the Contract.
 - b. The daily log must contain a record of the number of trees that are dug and side boxed per day, and when bottoming and moving takes place.
 - c. Refer to the plant inventory provided by the Program/Project Manager listing all plants to be boxed.
 - d. Pre-printed log sheets will be available to record the necessary information.
 - e. Submit the Daily Plant Salvage Log to the Program/Project Manager for approval weekly.



2. The Program/Project Manager will observe salvage, transportation, and storage operations periodically to review overall conditions including compliance with accepted maintenance standards.
 - a. The Work and equipment will be observed by the Program/Project Manager, and must be approved by him.
 - b. The recorded Saguaro Cacti calibrated measurements, photographs, and visual inspections will be used as tools by the Program/Project Manager to determine if the health and/or vigor of the Saguaro cacti are in reasonably close conformity to the appearance each displayed prior to its initial removal and transplant.
 - c. The Program/Project Manager will review transplanted material every month for overall condition.
 - 1) The Program/Project Manager and the Construction Manager at Risk will together calculate the acceptable mortality quantity (AMQ) of each species.
 - 2) The acceptable mortality quantity (AMQ) for each species is determined by multiplying the assigned acceptable mortality quantity percent (AMQP) as indicated in Table 02237-2 by the total species amount, and rounding the result down to the nearest whole number.



Table 02237-2 Acceptable Mortality Quantity Percent (AMQP)		
Species	Common Name	AMQP
Carnegiea gigantea	Saguaro cactus	10
Fouquieria splendens	Ocotillo	25
Ferocactus wislizenii	Fishhook barrel	25
Olneya tesota	Ironwood tree	10
Cercidium microphyllum	Foothills palo verde	10
Cercidium floridum	Blue palo verde	10
Prosopis velutina	Velvet mesquite	10
Opuntia species	Prickly Pear	25
Cactus species	Other cactus	25
Ebenopsis ebano	Texas Ebony	10
Phoenix dacylifera	Date Palm	20

B. Non-Conforming Work

1. If the material inspected is deemed by the Program/Project Manager to be in unsatisfactory condition prior to completion of the Contract, replace the material with like kind and size at no increase in Contract Price.
 - a. If the acceptable mortality quantity (AMQ) is exceeded for any species, obtain replacement trees or saguaros of the same species and of equal size, quality, and caliper and/or height (saguaro) from other approved sources for the unacceptable plant materials.
 - b. Replacement plant materials will likewise be observed by the Program/Project Manager, and are subject to the same inspection and acceptance requirements as salvaged plants.
2. Remove salvaged and replacement plant materials determined to be unacceptable by the Program/Project Manager from the nursery and/or temporary holding yard within 15 working days from notification.

3.07 CLEANING

- A.** Clean up the debris from salvage operations, and remove it offsite in a legal manner.

- B.** Waste Management:



1. Gather and dispose of spoils and vegetative waste, including dead and damaged plants and the trimmings accumulated from the operations.
2. Dispose of spoils and vegetative waste offsite in conformance with the regulations imposed by the local authorities, and in an area approved for such disposal by the local authorities.

3.08 MAINTENANCE

A. Watering Stored Salvaged Plants:

1. Watering is the responsibility of the Construction Manager at Risk.
2. Salvaged Plant Watering Schedule:
 - a. Water the plants as needed, depending on the season, to keep the stored plants healthy.
 - b. Water plants 3 times a week from May through October.
 - c. Water plants 2 times a week from November to April.
 - d. Cacti/Bare Root Material:
 - 1) No water shall be provided to Saguaro Cactus for a period of fourteen (14) days following excavation.
 - 2) Water cacti/bare root material 2 times per month from May to October.
 - 3) Water cacti/bare root material 1 time per month from November to April.
3. Boxed Material:
 - a. Water boxed material until water runs from the bottom of the box to insure the soil is totally saturated.
 - b. Typically, the entire rootball should be saturated in 4 hours.
4. Bare Root Material:
 - a. Water *fouquieria splendens* (Ocotillo) using overhead spray heads to insure the branches will be wet down during watering.
 - b. Water cacti using a drip irrigation line in a well around the base and insuring that water does not come in direct contact with the cactus base.
5. Periodically check rootballs for excessive runoff caused by cavities in the soil and holes in box sides.
6. Repack soil and repair boxes as necessary, causing minimal damage to the rootball.

B. Weeding and trimming:

1. Maintain the boxed plants in a weed free condition and trim all suckers at the base of the plants.

C. Pest Control:

1. Spray trees with appropriate pesticides as directed by Program/Project Manager.

D. Disease Control:



1. Use soil sulfur for disease control on cacti.

E. Irrigation:

1. Check the irrigation system and delivery to each plant for proper function and distribution of appropriate water quantities.

F. Fertilization:

1. Slow Release Fertilizer:

- a. Fertilize trees with 19/3/10 slow release fertilizer in late February and early July per Table 02237-3.

Table 02237-3 Slow Release Fertilizer Application	
Box Size (Inches)	Number of Cups
24	1
30	1.5
36	2
42	2.5
48	3
54	4
60	5

2. Nutrient Replacement

- a. Apply nutrient replacement to all trees and shrubs.
 - 1) Use one-half pound per 25 gallons of water for 2 applications at 30 Day intervals.
 - 2) For additional monthly applications use one-fourth pound per 25 gallons of water.
- b. Apply nutrient replacement to boxes per Table 02237-4.

Table 02237-4 Nutrient Replacement	
Box Size (Inches)	Number of Gallons
24 - 30	5
36 - 42	10
48 - 54	15
60 - 72	20



Table 02237-4 Nutrient Replacement	
Box Size (Inches)	Number of Gallons
84 and greater	25

G. Mulching

1. Cover the top of the rootball of boxed plants with 4 inches of organic compost.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for earth moving activities, including but not limited to the following:
 - a. Removing unsuitable onsite fill material.
 - b. Screening and selecting suitable onsite fill material.
 - c. Excavating, filling, backfilling, and compacting material to attain the required grades and densities.
 - d. Rough and finish grading.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01568 - Temporary Tree and Plant Protection.
 - 3. Section 02316 - Trenching and Backfilling.
 - 4. Section 02339 - Subgrade Preparation.
 - 5. Section 02721 - Aggregate Base Course.

1.02 REFERENCES

- A. Definitions:
 - 1. Contractor: The Contractor.
 - 2. Completed Course: A course or layer that is ready for the next layer or next phase of the work.
 - 3. Imported Material: Material obtained from sources off the Site that are suitable for a specified use.
 - 4. Lift: A layer of fill material.
 - 5. Miscellaneous Unclassified Excavation: Unclassified excavation required by the Program/Project Manager and not included in other items for payment.
 - 6. MSE Wall: A mechanically stabilized earth retaining wall which is a wall having a reinforced fill zone.
 - 7. Optimum Moisture Content: The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.
 - a. Determine Optimum Moisture Content in accordance with ASTM D 2216 for the maximum dry density for relative compaction.
 - 8. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.
 - 9. Project Limits: Areas, as shown on the Contract Drawings or specified, within which the Work is to be performed.



10. Proof Rolling: Subgrade testing to identify areas that will not support future loading without excessive deflection or deformation that is performed by observing passes of a suitably heavy rubber-tired construction vehicle.
11. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by the Standard Proctor test specified in ASTM D 698.
 - a. For oversize material, corrections are applied to either the as-compacted field dry density or the maximum dry density as determined by the Program/Project Manager and as specified in ASTM D 4718.
12. Select Offsite Borrow Material: Materials from designated borrow areas located off site.
13. Select Onsite Fill Material: Materials available onsite that the Program/Project Manager determines to be suitable for a specific use.
14. Structural Fill: Materials obtained from select offsite borrow material and/or select onsite fill material and used for support of pavement, building slabs, exterior slabs, structure foundations, and within a 10-foot lateral distance of building edges and building appurtenances.
15. Subgrade: The areas upon which rest the planned bottoms of foundations or slabs, and the surfaces upon which aggregate layers are placed below slabs and pavements.
16. Unclassified Excavation: Removal of materials of whatsoever nature in the excavation, including both earth and rock excavation, and other consolidated mineral mass, and existing structure foundations as may be encountered in the excavation.
17. Unclassified Excavation Below Subgrade: Same as unclassified excavation except such excavation is performed below elevations given as subgrade.

B. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO T-99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
2. ASTM International (ASTM):
 - a. ASTM D 75 - Standard Practice for Sampling Aggregates.
 - b. ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.
 - c. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN·m/m³)).
 - d. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.



- e. ASTM D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- f. ASTM D 2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- g. ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
- h. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- i. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- j. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- k. ASTM D 4718 - Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
- 3. Arizona Revised Statutes (ARS):
 - a. Chapter 2, Article 6.3, Underground Utilities, ARS 40-360.21 through 32.
 - b. Chapter 2, Article 6.4, Overhead Powerline Safety Law, ARS 40-360.41, 45.
- 4. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Specifications for Public Works Construction.
- 5. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.
 - 2. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.



- a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
- b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Samples:
 - 1) Representative samples of proposed select onsite fill.
 - 2) Representative samples of proposed imported material.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

- 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency may be necessary to obtain approval of portions of the Work of this Section.

B. Qualifications:

- 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements, to perform Special Inspections.
- 2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered Special Inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements

C. Site Samples:

- 1. Submit representative samples of proposed select onsite fill.
- 2. Submit representative samples of proposed imported material.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:



1. Do not deliver imported materials to the Site until the proposed source and materials tests have been tentatively accepted in writing by the Program/Project Manager.
 2. If it is necessary to haul wet soil material over roadways, use suitably tight vehicles to prevent spillage.
 - a. Clear away spilled material resulting from hauling operations from roadways.
- B. Storage and Handling Requirements:
1. Storage of Approved Materials:
 - a. If approved materials are not used immediately, store or stockpile the various approved materials.
 - b. Do not mix various approved materials together or mix approved materials with unapproved materials unless approved by the Program/Project Manager.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
1. Do not perform excavating, backfilling, or compacting operations when either weather conditions or the condition of the materials are such, in the opinion of the Program/Project Manager, that the work cannot be performed satisfactorily.
 2. Provide effective dust control measures on the Site to prevent the spread of dust during earth moving operations.
 - a. Thoroughly moisten excavation areas by dampening the soil, or employ other similar methods as approved by the Program/Project Manager.
- B. Existing Conditions:
1. Assume the risks attending to the presence or proximity, if any, of overhead or underground public utility and private lines, pipes, conduits and their associated support work, and other structures and property of every kind and description, in or over the excavation, or in the vicinity of the work, whether above or below the surface of the ground.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Granular Fill:
1. Provide approved material conforming to the requirements specified in MAG Uniform Standard Specifications for Public Works Construction Section 206, Structure Excavation and Backfill, and to Section 02316, Trenching and Backfilling, except as modified by this Section.



2. Provide granular fill that meets the requirements specified in Table 02300-1.

Table 02300-1 Granular Fill Requirements	
Characteristic / Item	Value
Maximum particle size	3 inches
Percent passing 3/4-inch sieve	50 to 100
Percent passing No. 8 sieve	30 to 80
Percent passing No. 200 sieve	0 to 12
Maximum plasticity index (PI)	5

B. MSE Wall Fill:

1. Provide approved material conforming to the requirements specified in MAG Uniform Standard Specifications for Public Works Construction Section 206, Structure Excavation and Backfill, and to Section 02316, Trenching and Backfilling, except as modified by this Section.
2. Provide MSE wall fill that meets the requirements specified in Table 02300-2.

Table 02300-2 MSE Wall Fill Requirements	
Characteristic / Item	Value
Maximum particle size	3 inches
Percent passing 3/4-inch sieve	50 to 100
Percent passing No. 8 sieve	30 to 80
Percent passing No. 200 sieve	0 to 12
Maximum plasticity index (PI)	5
Resistivity	> 3,000 ohm-cm
pH	5 < pH < 10
Chlorides	< 100 ppm
Sulfates	< 200 ppm
Organic Content, Maximum	1 percent

C. Non-Structural Fill:

1. Provide non-structural fill material conforming to the requirements specified in MAG Uniform Standard Specifications for Public Works Construction Section 211, Fill Construction, except as noted in this Section.



2. The non-structural fill may contain broken concrete, asphaltic concrete, cobbles, and/or boulders if the following limitations are adhered to:
 - a. The maximum dimension of these materials does not exceed 6 inches.
 - b. Pieces of these materials larger than 4 inches are not placed within 12 inches of a structure.
 - c. Pieces of these materials larger than 2-1/2 inches are not placed within 12 inches of the subgrade for paving.
 - d. Nesting of pieces of these materials is not permitted; and interstices must be filled with finer material.
 - e. Remove wire mesh and reinforcing steel from broken concrete.
3. Obtain approval of the material from the Program/Project Manager prior to using the material in performance of the Work.

D. Select Onsite Fill:

1. Classification of Excavated Materials:
 - a. Consideration will be given to the nature of materials encountered in onsite excavating operations for their later use as fill.
2. Provide onsite as-excavated material that is free of topsoil, roots, organic matter, vegetation, lumber, metal, refuse, concrete, asphaltic concrete rubble, boulders or similar hard objects larger than 6 inches, and other deleterious materials.

E. Structural Fill:

1. Provide approved material conforming to the requirements specified in MAG Uniform Standard Specifications for Public Works Construction Section 206, Structure Excavation and Backfill, and to Section 02316, Trenching and Backfilling, except as modified by this Section.
2. Provide structural fill that meets the requirements specified in Table 02300-3.

Table 02300-3 Structural Fill Requirements	
Characteristic / Item	Value
Maximum particle size	4 inches
Percent passing 3/4-inch sieve	50 to 100
Percent passing No. 8 sieve	30 to 80
Percent passing No. 200 sieve	0 to 30
Maximum plasticity index (PI)	15

F. Pipe Bedding:



1. Provide crushed aggregate pipe bedding materials complying with the requirements for either Select Material Type B or Aggregate Base as specified Table 02721-1 Crushed Aggregate Gradation in Section 02721, Aggregate Base Course.
2. Do not use open graded rock without the written approval of the Program/Project Manager.

G. Unsuitable Material:

1. Unsuitable material consists of organic material, oil, alkali, chemical compounds, rubble, rubbish, wood, and other substances subject to decomposition.

H. Water:

1. Provide water for compaction as required that is free of toxic contaminants and contaminants deleterious to proper compaction.

2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Imported Material Acceptance Test:

a. Test Procedure:

- 1) Notify the Program/Project Manager at least 24 hours prior to the required sampling of the imported material.
 - a) The Program/Project Manager's Testing and Inspection Agency will perform the sampling procedures by taking representative samples of the material at the source in accordance with ASTM D 75.
 - b) The samples will be clearly marked to show the source of the material and the intended use of the material on the Project.
- 2) Each material will be tested in accordance with the requirements specified for the material in Article 2.01.

b. Acceptance Criteria:

- 1) Tentative acceptance of the material source is at the Program/Project Manager's discretion, and will be based on observation of the source by the Program/Project Manager and/or the certified test results.
- 2) Before the material may be used, copies of the test results indicating that the materials comply with specified requirements must be received from the Testing and Inspection Agency.
- 3) Final acceptance of the material will be based on tests made on field samples of material taken from the completed and compacted course.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Notify the Program/Project Manager of unexpected subsurface conditions, and discontinue working in the affected area until notified to resume work.
- B. Pre-Installation Testing:
 - 1. Select Onsite Fill:
 - a. Only certain onsite materials may meet the requirements of select onsite fill material.
 - b. To obtain approval of each type of soil encountered and proposed to be used as select onsite fill, submit the following items to the Program/Project Manager for testing and evaluation:
 - 1) Representative sample of the material in a 5-gallon container or appropriately sized cloth sample bags.
 - 2) Information that identifies the location, extent, and quantity of material represented by the sample.
- C. Evaluation and Assessment:
 - 1. Select Onsite Fill:
 - a. Regardless of the source, written approval from the Program/Project Manager is required prior to using any material as select onsite fill.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Provide and maintain protection to retain earth banks and to protect adjoining grades and structures from caving, sliding, sloughing, erosion, or other damage.
 - 2. Protect trees, shrubs, and other features remaining as a portion of final landscaping in accordance with Section 01568, Temporary Tree and Plant Protection.
 - 3. Protect benchmarks, utilities, paving, and curbs from equipment and vehicular traffic.
 - 4. Protect any above-grade and below-grade utilities which are to remain.
 - 5. Protect installed piping and other work against damage from uplift or heave due to high ground water levels.
 - 6. Do not obstruct fire hydrants.
- B. Surface Preparation:
 - 1. Provide suitable structure supports where excavations are in the vicinity of buildings or structures which by their construction or position might exert detrimental pressure on the excavations.



2. Prior to the final disposition of obstructions, uncover and sustain the obstructions.
 - a. If existing sewers, storm drains, or conduits that do not require removal, realignment, or complete reconstruction are encountered, and in the judgment of the Program/Project Manager it is necessary to break through and reconstruct the invert or arch of the obstruction, perform this work.
 3. Plan the Work so adequate protection during storms is provided and materials are available for preventing flood damage.
 - a. Maintain storm sewers, drains, and ditches free of debris to facilitate surface drainage.
 - b. Do not direct the flow of water across or over pavements except through approved pipes or properly constructed troughs of adequate size and length to carry flows.
 - c. Do not allow damming or ponding of water in gutters or other waterways to occur.
- C. Demolition/Removal:
1. Remove, realign, or change the direction of above-ground or below-ground utilities and their appurtenant supports if required by the Program/Project Manager.

3.03 EXCAVATION

- A. Limits of Excavation:
1. Excavate to the finished grade elevations shown on the Contract Drawings.
 2. Excavate to the widths necessary to perform the Work allowing for the working space and/or aggregate base as shown on the Contract Drawings or as required.
 3. Replace excavation carried below the grade lines shown as follows:
 - a. If the overlying area is to receive fill or backfill, backfill the over-excavated volume with the same fill material specified for the overlying fill or backfill, and compact it as specified for the overlying fill or backfill.
 - b. If the overlying area is not to receive fill or backfill, replace the over-excavated material, and compact it to a relative compaction not less than that specified for structural fill.
- B. Excavation Equipment:
1. Perform excavation using machinery, except employ hand excavation where necessary to protect existing structures, buried utilities, or private or public properties.
- C. Excavation to Subgrade:



1. The method of excavation is at the Contractor's option; however, do not operate equipment within 5 feet of new structures or newly completed construction without prior approval of the Program/Project Manager.
 - a. Perform excavation that cannot be accomplished without endangering newly completed construction with hand tools.
2. Perform excavation of every description and of whatever substances encountered to the lines and grades or depths indicated by the Contract Drawings and as specified herein.
3. Remove subsurface materials of whatever nature, including boulders, rock, concrete, and construction debris, down to subgrade elevation.
 - a. Properly separate and store removed subsurface materials as suitable for use as fill.
4. Where work space is limited, remove excavated material from the limited area and replace the material after the structure has been installed.

D. Excavation Below Subgrade:

1. If through the fault of the Contractor excavations extend below the design depths or below the depths required by the Program/Project Manager, restore the excavation to the required depth with structural fill.

3.04 DEWATERING

A. Dewatering Excavations:

1. Remove all water during periods when concrete is being deposited, when pipe is being laid, during the placing of backfill, and at such other times as required for efficient and safe execution of the work.
2. Keep excavations free from water during the performance of the work.
3. Furnish and operate dewatering equipment having sufficient capacity for dewatering the excavations.
4. Control groundwater and surface water during construction in order to maintain soil stability.

B. Water Disposal:

1. Dispose of the water removed from excavations so that it does not cause injury to the public health, to public or private property, to the work of others, or to portions of the work completed or in progress, and does not cause an impediment to the use of streets, roads, and highways.

3.05 SHORING, SHEETING, BRACING, AND SLOPING

- A. Install and maintain shoring, sheeting, bracing, and sloping as necessary to support the sides of the excavation; to keep and to prevent any movement which may damage adjacent pavements, utilities, or structures; damage or delay the work; or endanger life and health.



- B. Install and maintain shoring, sheeting, bracing, and sloping as required by the Occupational Safety and Health Administration (OSHA) and other applicable governmental regulations and agencies

3.06 SUBGRADE PREPARATION

- A. After completion of excavations other than utility excavations, prepare the subgrade in accordance with the requirements of Section 02339, Subgrade Preparation.

3.07 FILLING AND BACKFILLING

- A. Borrow Material:
 - 1. The required quantity of fill may exceed the quantity of suitable onsite material.
 - 2. If borrow excavation is needed for fill material, notify the Program/Project Manager sufficiently in advance of borrow excavation work to permit the Program/Project Manager to verify the need for the borrow excavation, and to view the proposed borrow pit to determine the suitability of the material.
 - a. Borrow material from outside sources must be suitable in every respect, meeting specified requirements for the type of material, and will be subject to the Program/Project Manager's approval.
 - b. Prior to using borrow material from outside sources, obtain the Program/Project Manager's written consent.
- B. Fill Restrictions:
 - 1. Prior to placing fill, clean the excavation so it is free of trash and debris.
 - 2. Do not place backfill material adjacent to concrete structures until the concrete has attained at least 2/3 of its specified compressive strength.
 - 3. Do not place fill material on areas of ponded water or on surfaces that are muddy.
 - 4. Do not operate heavy equipment within 3 feet of walls.
 - 5. Do not operate earth-moving equipment within 5 feet of the walls of concrete structures to deposit or compact backfill material without prior approval by the Program/Project Manager.
 - a. Only small walk-behind compactors are allowed to operate within this zone unless otherwise indicated by the Program/Project Manager.
 - 6. Do not use wet materials containing moisture in excess of the amount necessary for satisfactory compaction as backfill.
 - 7. For walls to receive fill on both sides of the wall, backfill by alternately placing backfill material so the material heights on each side of the wall do not differ by more than 18 inches.
- C. Fill Placement:



1. Use machinery to place and compact fill, except where necessary to prevent damaging or displacing walls, foundations, or buried utilities fill or backfill by hand.
2. Prior to placing dry fill or backfill material not having sufficient moisture to obtain satisfactory placement or compaction, moisten the fill or backfill material.
3. Aggregate Base:
 - a. Place aggregate base courses directly on excavation bottoms and, where required, on completed structural fills.
 - b. Place aggregate base in loose lifts not exceeding 8 inches in thickness.
4. Granular Fill:
 - a. Place granular fill as backfill for retaining walls.
5. MSE Wall Fill:
 - a. Place MSE wall fill in the reinforced fill zone of mechanically stabilized earth walls.
6. Non-structural Fill:
 - a. Place non-structural fill in uniform horizontal layers not exceeding 8 inches in compacted thickness.
7. Structural Fill:
 - a. Place structural fill in uniform horizontal layers not exceeding 8 inches in compacted thickness.

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Retaining Wall Backfill

3.08 COMPACTION

- A. Compaction Equipment:
 1. Perform compaction using compaction equipment suitable for the material being placed.
 - a. Furnish compaction equipment of a type suitable and adequate to obtain the relative compaction specified, and that satisfactorily breaks down materials to form dense fill.
 - b. If inadequate relative compactions are obtained, furnish larger and/or different types of equipment.
 - c. If hand-operated equipment is furnished, furnish equipment capable of achieving the specified relative compaction.
 2. Operate compaction equipment in strict accordance with the manufacturer's instructions and recommendations.
 3. Maintain compaction equipment in a condition capable of delivering the manufacturer's rated compactive effort.
- B. Compacting Fill and Backfill:
 1. Compact the fill and backfill with vibratory compaction equipment as indicated in the Construction Documents to the satisfaction of the Program/Project Manager.
 - a. Compact all fill and backfill materials by mechanical means to the densities and moisture content specified.



2. Aggregate Base:
 - a. Compact each layer of the aggregate base course with vibratory compaction equipment to at least 98 percent of the maximum dry density as specified in ASTM D 698.
 3. Structural Fill, MSE Wall Fill, and Granular Fill:
 - a. Maintain the moisture content of structural fill, MSE wall fill, and granular fill at compaction within 2 percentage points of optimum moisture content as determined in accordance with the requirements of ASTM D 698.
 - b. Compact structural fill, MSE wall fill, and granular fill to at least 95 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698.
 - c. Compact the upper 2 feet of structural fill and granular fill in utility trenches below pavement and slab areas to at least 98 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698.
 4. Non-structural Fill:
 - a. Do not nest larger particles.
 - b. Maintain the moisture content of non-structural fill at compaction within 3 percentage points of optimum moisture content as determined in accordance with the requirements of ASTM D 698.
 - c. Compact non-structural fill to at least 90 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698.
- C. Moisture Control:
1. During compacting operations, maintain the optimum practicable moisture content in each lift of fill required for compaction purposes.
 - a. At the time of compaction, maintain the water content of the material at the optimum moisture content, plus or minus 2 or 3 percentage points as indicated in Paragraph 3.08.B.
 2. Maintain uniform moisture content throughout the lift.
 - a. Add water to the material at the excavation site insofar as practicable.
 - b. If required, supplement the moisture content by sprinkling the fill.
 3. Do not attempt to compact fill material that contains excessive moisture.
 4. Moisture Control Equipment:
 - a. Furnish equipment for applying water that is of a type and quality adequate for the work, that does not leak, and that is equipped with a distributor bar or other approved device to assure uniform application of the water.
- D. Other Materials and Equipment:
1. Furnish equipment for mixing and drying out material that consists of blades, discs, or other approved components.
 2. Furnish all other materials and equipment not specifically described but required for a complete and proper installation.



- a. All such Contractor-selected equipment is subject to review by the Program/Project Manager prior to use.

3.09 FINISH GRADING

- A. Finish grade all areas to the elevations and grades indicated in the Construction Documents.
- B. Perform grading in the vicinity of excavations so the ground surface is properly pitched to prevent water running into excavated areas.
 1. Grade the top perimeter of excavations to prevent surface water runoff from flowing into excavations.

3.10 REPAIR / RESTORATION

- A. Responsibility for damages and expenses arising out of the Work, for direct or indirect injury to such structures or to any persons or property by reason of them, or by reason of injury to them, whether such structures are or are not indicated on the Contract Drawings, rests solely with the Contractor.

3.11 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. The approved independent Testing and Inspection Agency will perform the testing specified in this Paragraph 3.11.A, and submit the test results to the Program/Project Manager and Contractor for information.
 - a. The Program/Project Manager may require additional tests whenever necessary to ensure that the specified density is being obtained.
 - b. If it appears that material, whether it is in stockpiles or is being placed, differs from that which has previously been approved for use, the Program/Project Manager may require retesting the material.
 - 1) Differences that may result in retesting include, but are not limited to, differences in grain size, color, texture, plasticity, or workability.
 - 2) Placing material represented by material requiring retesting during the interim period between taking a retest sample and receiving the test results is at the Contractor's risk.
 2. Laboratory Moisture-Density Tests:
 - a. Test Procedure:
 - 1) At least one laboratory moisture density determination test will be performed for each different soil being placed.
 - 2) The laboratory moisture-density tests will be performed in accordance with the methods specified in ASTM D 698.
 - b. Acceptance Criteria:
 - 1) Test results conforming to the requirements specified in Article 3.08 for the type of material are acceptable.
 3. In-Place Field Density Tests:



- a. Test Procedure:
 - 1) In-place field density tests will be performed in accordance with the methods specified in ASTM D 1556 or ASTM D 2922.
 - a) If the methods of ASTM D 2922 are used for in-place field density testing, the moisture content will be determined as specified in ASTM D 3017.
 - 2) For structural fills, at least one field moisture-density determination test will be performed for each 5,000 square feet below building areas and 10,000 square feet below parking areas.
 - a) The field moisture-density determination test will be performed for each compacted fill and backfill layer, not to exceed 8 inches compacted thickness.
 - 3) For granular and MSE wall fills, at least one field moisture-density determination test will be performed for each 100 feet of wall below slab and pavement areas and for each 150 feet of wall below landscaping areas.
 - a) The field moisture-density determination test will be performed for each compacted fill and backfill layer, not to exceed 8 inches compacted thickness.
 - 4) For non-structural fills, at least one field moisture-density determination test will be performed for each area of 10,000 square feet.
 - a) The field moisture-density determination test will be performed for each compacted fill and backfill layer, not to exceed 8 inches compacted thickness.
- b. Acceptance Criteria:
 - 1) Test results conforming to the requirements specified in Article 3.08 for the type of material are acceptable.

B. Non-Conforming Work

- 1. If testing indicates that a material does not meet the specified requirements, terminate placement of that material until corrective measures have been taken.
 - a. Whenever tests indicate that the field moisture or density does not meet specified requirements, take corrective action as approved by the Program/Project Manager.
 - 1) Corrective measures may include loosening the soil and wetting or drying it prior to re-compaction, additional compaction, or removing and replacing the material.
 - 2) Retest material that did not meet the moisture and density requirements after corrective measures have been performed.
 - b. For disapproved material, either submit samples for retesting for the sieve analysis, maximum dry density, optimum moisture content, liquid limit and plastic limit for approval of new borrow material, or procedures and materials proposed to render the disapproved material suitable for use.



2. Remove material which does not conform to the specified requirements but was placed in the Work, and replace the removed material with the specified material.
 - a. In the event that material that was previously approved for use is retested, and the retesting indicates that the material does not meet the specified requirements, moisture-condition and recompact the material in accordance with the specified requirements, or remove the material represented by the retest from the Work, and replace it with approved material.

3.12 CLEANING

- A. Cleanup:
 1. Remove excess excavated material that cannot be used at the Site, and dispose of it offsite in a lawful manner.
- B. Waste Management:
 1. No right of property for excavated materials is granted to the Contractor prior to filling.
 - a. The Contractor is not relieved of responsibility for removing and disposing of surplus excavated material or excavated materials not suitable for use as fill.

3.13 MAINTENANCE

- A. Maintain cut slopes as required for stability and safety during the duration of the Contract.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.





SECTION 02316

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Excavating, backfilling, and compacting trenches for inline structures and pipelines within the limits and to the depths indicated on the Contract Drawings or as specified.
 - a. Excavation for appurtenant structures, such as manholes, inlets, transition structures, junctions, vaults, valve boxes, catch basins, and similar structures are included in trenching.
 - b. Unless otherwise shown on the Contract Drawings or approved by the Program/Project Manager, perform open cut excavation for trenches.
 - 2. Requirements for pavement replacement where trenches are opened in paved areas.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 02721 - Aggregate Base Course.
 - 4. Section 02741 - Bituminous Concrete Pavement.
 - 5. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

- A. Definitions:
 - 1. Bedding: Material to be placed in pipe trenches filling the volume from the bottom of the trench to 1 foot above the top of the buried pipe or conduit, excluding the pipe and its interior.
 - 2. Springline or Springing Line: In a transverse cross section of pipe, the line of maximum horizontal dimension.
 - 3. Unsuitable Material: Material consisting of organic material, oil, alkali, chemical compounds, rubble, rubbish, wood, and other substances subject to decomposition.
- B. Reference Standards:
 - 1. American Association of State Highway Transportation Officials (AASHTO):
 - a. AASHTO M 82 – Standard Specification for Cutback Asphalt (Medium-Curing Type).
 - b. AASHTO M 226 - Standard Specification for Viscosity-Graded Asphalt Cement.



- c. AASHTO T 90 - Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
- d. AASHTO T 99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
- e. AASHTO T 191 - Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
- f. AASHTO T 224 – Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test
- 2. ASTM International (ASTM):
 - a. ASTM C 33 - Standard Specification for Concrete Aggregates.
 - b. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - c. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - d. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - e. ASTM D 4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - f. ASTM D 5084 - Standard Test Methods for Measurement of Hydraulic conductivity of saturated Porous Materials Using a flexible Wall Permeameter.
 - g. ASTM D 5982 - Standard Test Method for Determining Cement Content of Fresh Soil-Cement (Heat of Neutralization Method).
 - h. ASTM D 6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
- 3. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - b. Phoenix Supplemental Standard Details for Public Works - Construction:
 - 1) Detail No. P1200 Trench Backfill & Surface Replacement.
 - 2) Detail No. P1270 Frame and Cover Installation and Grade Adjustment.
 - 3) Detail No. P1343 Waterline – Cut & Plug for 12” Dia. Main and Smaller.
 - 4) Detail No. P1344 Waterline Cut Out (Tees & Crosses) for 12” Dia. Main and Smaller.
 - 5) Detail No. P1391 Valve Box Installation.
- 4. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Specifications for Public Works Construction.
 - b. MAG Uniform Standard Details for Public Works Construction.
 - 1) Detail No. 301 Blocking for Water Gate and Butterfly Valves.
 - 2) Detail No. 340 Installing Tapping Sleeves and Valves.
 - 3) Detail No. 370 Vertical Realignment of Water Mains.



- 4) Detail No. 380 Thrust Blocks for Water Lines.
- 5) Detail No. 381 Anchor Blocks for Vertical Bends.
- 6) Detail No. 403-1 Pipe Supports Across Trenches.
- 7) Detail No. 403-2 Pipe Supports Across Trenches.
- 8) Detail No. 403-3 Alternate to Pipe Support.
- 9) Detail No. 404-1 Water and Sanitary Sewer Separation/Protection.
- 10) Detail No. 404-2 Water and Sanitary Sewer Separation/Protection.
- 11) Detail No. 404-3 Water and Sanitary Sewer Separation/Protection
- 12) Detail No. 405 Broken Sewer Line Replacement.
- 13) Detail No. 422 Manhole and Cover Frame Adjustment.
5. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit.
 - 3) Dust Control Logs.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/qa/divisions/planning_analysis/rules/docs/200-0803.pdf.
6. State of Arizona:
 - a. Arizona Revised Statutes (ARS):
 - 1) ARS 40-360.21 through 32 - Chapter 2 Public Service Corporations Generally, Article 6.3, Underground Utilities,
 - 2) ARS 40-360.41 through 45 - Chapter 2 Public Service Corporations Generally, Article 6.4, High Voltage Power Lines and Safety Restrictions.
7. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Property Owner:

- a. Depending on where the trenching operation is to occur and the owner of the property or right-of- way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - 1) Phoenix Sky Harbor International Airport.
 - 2) City of Phoenix Streets Department.



- 3) Maricopa County.
 - 4) Arizona Department of Transportation (ADOT).
 - b. Adhere to each owner's specifications and/or permits, and comply with additional requirements of the owners, regarding the Work of this Section.
 - c. If the owner of the property or right-of-way is other than the Phoenix Sky Harbor International Airport, the name of the owner of the property or right-of-way will be provided on the Contract Drawings.
2. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.
3. Utility Owners:
 - a. Coordinate with the various utility companies regarding the adjustment and inspection of their facilities.
 - 1) Adhere to each utility's specifications during adjustments.
 - 2) Comply with additional requirements of the utilities.
 - b. Conflicting Waterlines:
 - 1) If a trenching operation exposes 4 feet or more of an existing 12-inch or smaller water line, excluding service lines, then notify the City of Phoenix Water Distribution Division of the Water Services Department to isolate the conflicting waterline undercrossed by the excavation either by operating existing valves or cutting in new valves.
 - a) Request a shut-down at least 1 week in advance by contacting the City of Phoenix Water Distribution Division at either (602) 262-4711 or (602) 262-4712.
 - b) City forces will perform the shutdown or cut-in work.
 - c) If the unanticipated conflict can be resolved using offset pipe joints, coordinate with the City of Phoenix Water Distribution Division to obtain the offset pipe joints from the City's Water Stores Warehouse, and notify the City Inspector at least 24 hours prior to performing the work to schedule picking up the materials, and install the offset joints.
 - 2) After the existing undercrossed waterline has been isolated, remove a portion of the waterline sufficient to allow the new



- mainline pipe or structure to be installed under it as indicated on the Contract Drawings.
- 3) Once the new mainline pipe or structure has been installed, replace the portion of the waterline previously removed with same size and type of pipe that was removed, and extend the replacement pipe at least 5 feet into undisturbed ground beyond the trench wall.
 4. Irrigation Facilities:
 - a. Prior to trenching in the vicinity of irrigation facilities, including ditches, pipes, and structures, contact the owners of the irrigation facilities to arrange for construction clearances and/or dry-up periods.
 - b. Perform backfill and compaction for irrigation lines of the Salt River Valley Water User's Association and Roosevelt Irrigation Districts in compliance with each entity's specifications and/or permits.
 5. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.
 - a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
 - b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Proposed source of imported materials.
 - b. Samples:
 - 1) Imported materials.
 - c. Certificates:
 - 1) Microseal Mix Certification.
 - d. Delegated Design Submittals:
 - 1) Mix design for the controlled low strength material (CLSM).

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Protect the excavations, and the safety of workers and the public, in conformance with the requirements of Occupational Safety and Health Administration (OSHA), particularly "Subpart P – Excavations" of 29 CFR 1926, and the following:
 - a. Shoring and Sheet piling:



- 1) Install bracing, sheathing, and/or shoring as necessary to excavations protect the excavations and safeguard the workers, the public, and the Program/Project Manager's representatives.
 - 2) To prevent overloading pipes and other structures in trenches during backfilling operations, do not remove the bracing, sheathing, and/or shoring in one operation, but remove it in successive stages as approved by the Program/Project Manager.
 - b. Open Trench Limits:
 - 1) Except where otherwise allowed or approved in writing by the Program/Project Manager, the maximum aggregate length of open trench at one location may not exceed 1320 feet.
 - a) The aggregate length of open trench is the sum of the lengths of concurrent excavation, pipe-laying, and backfilling operations at the location.
 - b) Excavated areas are considerate to be open trench until they are completely backfilled, compacted, and the surface is restored, including completion of pavement replacement where required. If approved by the Program/Project Manager, trench excavations may be opened at more than one separate location.
 - c. Incomplete Street Crossings:
 - 1) At street crossings where trench backfill and temporary patches have not been completed during regular working hours, provide substantial steel plates with adequate trench bracing to bridge across the trenches and accommodate traffic.
 - d. Dust Control Permit:
 - 1) In accordance with Rule 200 of the Maricopa County Air Pollution Control Regulations, a Dust Control Permit issued by the Maricopa County Air Quality Department is required for Sites where more than 0.1 acre (4356 square feet) of soil will be disturbed.
 - a) If a Dust Control Permit is required for this Contract, follow the instructions in the Maricopa County Air Quality Department's "Guidance for Dust Control Permit for Application" and file the "Application for Dust Control Permit", which requires including a Dust Control Plan with the Application, and pay the permit fees in accordance with Maricopa County Air Pollution Control Regulation Rule 280.
- B. Certifications:
1. Microseal Mix Certification:
 - a. Submit the microseal job mix formula and certified test results for it from an approved laboratory to the Program/Project Manager for approval.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Do not deliver imported materials to the Site until the proposed source and materials tests have been tentatively accepted in writing by the Program/Project Manager.
 - a. Submit the proposed source of imported materials and materials Samples for testing to the Program/Project Manager for approval.
 - 2. If it is necessary to haul wet soil material over roadways, use suitably tight vehicles to prevent spillage.
 - a. Clear away spilled material resulting from hauling operations from roadways.
- B. Storage and Handling Requirements:
 - 1. Storage of Approved Materials:
 - a. If approved materials are not used immediately, store or stockpile the various approved materials.
 - b. Do not mix various approved materials together or mix approved materials with unapproved materials unless approved by the Program/Project Manager.
 - 2. Storage of Excavated Material:
 - a. Pile excavated material that is suitable for use as backfill in an orderly manner, and a sufficient distance away from the edges of trenches so the trench walls are not overloaded and slides and/or cave-ins are avoided.
 - b. If the Contract Documents require the topsoil to be segregated from the underlying material, separate the 2 materials where they are stockpiled so they do not become mixed together.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not perform trench excavating, backfilling, or compacting operations when either weather conditions or the condition of the materials are such, in the opinion of the Program/Project Manager, that the work cannot be performed satisfactorily.
 - 2. Provide effective dust control measures on the Site to prevent the spread of dust during trenching operations.
 - a. Thoroughly moisten excavation areas by dampening the soil, or employ other similar methods as approved by the Program/Project Manager.
- B. Existing Conditions:
 - 1. Boring logs shown on the Contract Drawings or included in the Specifications are included for the Contractor's convenience only, and do not constitute a part of the Contract.



- a. It is not intended to imply that the character of the material is the same as shown on the logs at points other than where each boring was made.
 - b. It is the Contractor's responsibility to satisfy itself regarding the actual soil moisture content, and the amount of rock, gravel, sand, silt, clay, and water, to be encountered during the Work of this Section.
2. Assume the risks attending to the presence or proximity, if any, of overhead or underground public utility and private lines, pipes, conduits and their associated support work, and other structures and property of every kind and description, in or over the excavation, or in the vicinity of the work, whether above or below the surface of the ground.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Asphalt Emulsion:
 1. Provide modified asphalt emulsion materials complying with the requirements for emulsified asphalt as specified in Section 02686, Tack Coat.
- B. Bedding Materials:
 1. Crushed Aggregate:
 - a. Provide crushed aggregate bedding materials complying with the requirements either for Select Material Type B or Aggregate Base as specified in Section 02721, Aggregate Base Course, with gradations according to Table 02721-1 Crushed Aggregate Gradation.
 - 1) Provide granular material having the sum of the plasticity index, measured in accordance with the methods specified in AASHTO T 90, plus the percent of material passing a Number 200 sieve less than 23.
 - b. Do not use open graded rock without the written approval of the Program/Project Manager.
 2. Sand:
 - a. Provide sand complying with the grading requirements of ASTM C 33 for fine aggregate.
- C. Backfill Materials:
 1. Provide aggregate base course, granular backfill, or native backfill as indicated on the Contract Drawings and/or on the applicable Standard Drawings from the City of Phoenix and the Maricopa County Association of Governments.
 - a. Provide sound material free from broken concrete, broken pavement, wood, and other deleterious material.
 - b. Under pavement, sidewalk, or similar construction, backfill for the 12 inches directly below the subgrade may not be larger than 3 inches.



2. Aggregate Base:
 - a. Provide crushed aggregate complying with the requirements specified in Section 02721, Aggregate Base Course.
3. Granular Backfill:
 - a. Provide granular material having the sum of its plasticity index, measured in accordance with the methods specified in AASHTO T 90, plus the percent of the material passing a Number 200 sieve, equaling less than 23.
4. Excavated "Native" Backfill:
 - a. Excavated "native" material with pieces less than 4 inches is suitable for use as backfill for backfilling trench excavations.
 - 1) Excavated material having either excessive or inadequate moisture content is considered unsuitable, since it cannot be properly compacted; however, the following options may be elected:
 - a) At no increase in Contract Price, add or remove water to the unsuitable excavated material to bring it within the range of plus 2 percent to minus 4 percent of the optimum moisture content in order that the material can be properly compacted to the values specified in Table 02316-1.
 - b) In lieu of adding or removing water to the unsuitable excavated material to make it suitable for backfill as specified in Subparagraph 2.01.C.4.a.2.a, haul excessively dry or wet material offsite and legally dispose of it, and provide other material complying with the requirements specified for suitable backfill material to replace the material removed.
5. Controlled Low Strength Material (CLSM):
 - a. Provide controlled low strength material (CLSM) consisting of a cement-enriched aggregate base course slurry having the following properties:
 - 1) Cement Content:
 - a) Provide controlled low strength material (CLSM) having a cement content of 47 pounds per cubic yard plus or minus 5 percent when tested in accordance with the methods specified in ASTM D 5982.
 - 2) Slump or Flow Consistency:
 - a) Provide controlled low strength material (CLSM) having a slump of 7 inches plus or minus 1 inch when tested in accordance with the methods specified in ASTM C 143/C 143M, or flow consistency of 8 inches when tested in accordance with the methods specified in ASTM D 6103.
 - 3) Compressive Strength:



- a) Provide controlled low strength material (CLSM) having a compressive strength of 100 psi at 28 days when tested in accordance with the methods specified in ASTM D 4832.
- 4) Permeability Coefficient:
 - a) If the controlled low strength material (CLSM) is used as backfill around gas pipelines, it must totally encapsulate the pipeline, and have a minimum permeability coefficient, k , of 1×10^{-5} centimeters per second when tested in accordance with the methods specified in ASTM D 5084.
 - b. Submit a mix design for the controlled low strength material (CLSM) to the Program/Project Manager for approval prior to placing the controlled low strength material.
6. Decomposed Granite:
 - a. Provide decomposed granite as specified in Section 02721, Aggregate Base Course.
- D. Bituminous Concrete:
 1. Provide bituminous concrete materials and mixes in accordance with the requirements of Section 02741, Bituminous Concrete Pavement, and complying with the requirements specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications for the type of asphalt paving required.
- E. Cold Mix Bituminous Concrete:
 1. Provide cold mix bituminous concrete consisting of natural crude or refined asphalt petroleum, or a residual product thereof, combined with aggregate having the gradation shown in Table 02316-1.
 - a. For the asphalt petroleum, or residual product thereof, provide 6 percent plus or minus 0.4 percent medium curing type cutback asphalt complying with the requirements for either Grade MC-70 or MC-250 medium curing type cutback asphalt as specified in Table 1 in AASHTO M 82, or 5.5 percent of AC-2.5 viscosity-graded asphalt cement complying with the requirements of Table 1 in AASHTO M 226.
 - 1) The AC-2.5 asphalt binder must be heated for mixing.

Table 02316-1 Temporary Pavement Aggregate Gradation

Sieve Size	Percent Passing	Tolerance
3/4 inch	97 to 100	Plus or minus 7 percent
1/2 inch	88	Plus or minus 7 percent
3/8 inch	78	Plus or minus 7 percent
Number 4	60	Plus or minus 7 percent



Table 02316-1 Temporary Pavement Aggregate Gradation		
Sieve Size	Percent Passing	Tolerance
Number 8	47	Plus or minus 5 percent
Number 30	25	Plus or minus 5 percent
Number 200	5	Plus or minus 2 percent

F. Microseal Mix:

1. Provide a Grade CSS-1h polymerized cationic asphalt emulsion, modifier, aggregate, mineral filler, water, and additives complying with the requirements specified in Section 761, Microseal Specifications, of the Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction.

G. Slurry Seal:

1. Provide slurry seal materials complying with the requirements of Section 715, Slurry Seal Materials, of the Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Determine actual soil conditions, which may differ from those anticipated or indicated by available soil logs and/or reports.
2. Notify the Program/Project Manager of unexpected subsurface conditions, and discontinue working in the affected area until notified to resume work.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
2. Protect buildings, foundations, bridges, and other structures located adjacent to trenching operations from damage due to the trenching.
 - a. Unless authorized in writing by the Program/Project Manager, do not use water to settle backfill material in trenches adjacent to structures.
3. Safeguard and maintain conflicting utilities shown on the Contract Drawings, including overhead wires and cables and their supporting poles, whether or not they are inside or outside the trench.



- a. If a conflicting utility not shown on the Contract Drawings is discovered during the course of the Work, notify the Program/Project Manager as soon as possible.
 - 1) The Program/Project Manager will negotiate to have the owner of the conflicting utility relocate it, have others relocate the utility, change the alignment or grade of the trench to avoid the conflict, or declare the work to resolve the conflict as extra work.
 - b. Provide permanent pipe supports for sewer, water, and other utility lines where shown on the Contract Drawings and at other locations as deemed necessary by the Program/Project Manager.
 - 1) Provide permanent pipe supports in accordance with the details shown on the Contract Drawings, the MAG Uniform Standard Details for Public Works Construction, and the Phoenix Supplemental Standard Details for Public Works – Construction.
 - c. Adequately support electronic, telephonic, telegraphic, electrical, oil, and gas lines encountered; and avoid damaging plastic pipe, pipe-way, and conduits during foundation preparation, bedding placement and backfilling operations.
 - 1) Support plastic pipe and electrical conduit continuously along the bottom of the pipe or conduit.
 - 2) Support metal pipe and electrical conduit either continuously or suspend the pipe or conduit from nylon webbing spaced at intervals not more than 10 feet apart.
4. Unless otherwise indicated in the Contract Documents, maintain all underground and overhead utilities in continuous service throughout the duration of the Contract, and take responsibility and accept liability for damages or interruptions of service caused by the construction.
- a. If a utility or appurtenance is to be temporarily or permanently relocated or shut down, the Contractor is responsible for making the necessary arrangements and agreements with the owner of the utility and its reconstruction at no increase in the Contract Price.
 - 1) Reconstruct the utility or appurtenance and the property to its previous condition or better as soon as possible.
 - 2) The relocation or shutdown and restoration cycle is subject to inspection and approval by both the Program/Project Manager and the owner of the utility.
- B. Surface Preparation:
- 1. Furnish alignment and elevation stakes marking the trench grade at intervals and offsets agreed upon with the Program/Project Manager.
 - a. On Contracts that include water distribution Work, only furnish elevation stakes if required by the Program/Project Manager.
 - b. The Program/Project Manager will furnish cut sheets for Contracts requiring elevation stakes.

C. Demolition/Removal:



1. Pavement and Concrete Cutting and Removal:
 - a. Where trenches lie within paved streets, alleys, driveways, and/or sidewalks, cut the pavement as follows:
 - 1) Portland Cement Concrete:
 - a) Saw cut the pavement to neat, vertical, true lines without damaging the adjoining surface.
 - b) Cut the pavement to at least 1-1/2 inches or 1/4 of the pavement thickness, whichever is greater.
 - 2) Bituminous Pavement:
 - a) Use approved equipment and methods to clean-cut the bituminous pavement.
 - b. Do not rip or root outside the limits of the cuts.

3.03 TRENCHING

A. Trench Excavation:

1. Unless otherwise indicated on the Contract Drawings, provide pipe trench widths for pipe, other than cast-in-place concrete pipe, as indicated in Table 02316-2.

Table 02316-2 Pipe Trench Widths		
Pipe Size (Inside Diameter)	Maximum Width at Top Greater than Outside Diameter of Barrel	Minimum Width at Springline – Each Side of Pipe
Less than 18 inches	16 inches	6 inches
18 to 24 inches	19 inches	16 inches
27 to 39 inches	28 inches	16 inches
42 to 60 inches	1/2 the outside diameter	16 inches
Over 60 inches	36 inches	16 inches

2. Do not excavate the portion of the trenches below the top of the pipe wider than allowed by Table 02316-2.
 - a. If the maximum trench width specified in Table 02316-2 is exceeded, then provide the additional load bearing capacity necessary by using the following methods or a combination of the methods:
 - 1) Provide bedding with a higher bedding factor than that specified.
 - 2) Provide higher strength pipe.
 - 3) Provide a concrete cradle, cap, or encasement.
 - 4) Other means approved by the Program/Project Manager.



3. Above the top of the pipe, trenches may be excavated as wide as necessary for installing sheeting, shoring, or other wall supports or for slopping the trench walls as required for a safe and proper pipe installation.
4. Do not over-excavate below the elevations indicated in the Contract Documents, except at locations where excavation of rock from the trench is required.
 - a. Refill excavation extending below the indicated grade line or bottom elevation indicated for the foundation of structures with bituminous concrete compacted to a uniform density not less than 95 percent of the maximum density as determined by AASHTO T 99 and AASHTO T 191, or ASTM D 2922 and ASTM D 3017.
 - 1) If Methods A or B of AASHTO T 99 and AASHTO T 191 are used to determine the maximum density, correct the dry density using the rock correction procedure found in Standard Detail 190 in the MAG Uniform Standard Details for Public Works Construction.
 - b. Wherever rock is encountered during trench excavation, over-excavate to a minimum depth of 6 inches below the outside diameter of the pipe, and refill the over-excavated volume by placing granular material with the minimum possible compaction.
 - c. Wherever unsuitable soil, incapable of supporting the pipe, is encountered, notify the Program/Project Manager that a field investigation to determine a course of action is required.
 - 1) If the Program/Project Manager determines that, as a result of the presence of unsuitable material, over-excavation below the normal foundation and bedding depth and backfilling the void is required, this will be considered extra; work and an agreement on the method of payment and construction time extensions must be reached prior to the Contractor starting the work.
5. When excavating trenches for pipes 8 inches or larger in diameter, allow for an initial granular bedding of at least 4 inches or 1/12 the outside diameter of the pipe, whichever is greater.

B. Foundation Preparation:

1. Accurately finish the material upon which the conduit or structure is to be placed to the grade and/or dimensions shown on the Contract Drawings or as directed by the Program/Project Manager.
 - a. Bring the bottom portion of the trench to grade so the conduit or structure will be continuously in contact with the material on which it will be placed.
2. Bedding:
 - a. Place bedding in pipe trenches filling the volume from the bottom of the trench to 1 foot above the top of the buried pipe or conduit, excluding the pipe and its interior.
 - 1) For trenches being excavated for pipes 8 inches or larger in diameter, provide an initial granular material bed to a depth of at



- least 4 inches or $1/12$ the outside diameter of the pipe, whichever is greater, prior to placing the pipe in the trench and completing the backfilling.
- a) Place this bedding material so it has a uniform density with minimum compaction, and fine grade the bedding as specified herein.
 - 2) For electronic, telephonic, telegraphic, electrical, oil, and gas lines, provide native material or sand bedding.
 - a) Provide a 6-inch deep foundation consisting of native material or sand bedding.
 - b) If the backfill material to subsequently be placed in a trench for the electronic, telephonic, telegraphic, electrical, oil, or gas lines consists of aggregate base course, crushed stone, or other stone-containing material, then only sand may be used for the bedding material.
 - b. Where water consolidation will subsequently be used to compact the backfill, place the bedding as follows:
 - 1) Bedding for conduits with an inside diameter of 24 inches or less may be placed in 1 lift.
 - 2) Do not allow the first lift of the bedding for conduits larger than 24 inches to exceed the springline of the pipe.
 - c. Where mechanical consolidation will subsequently be used to compact the backfill, place the bedding as follows:
 - 1) Provide bedding having moisture content within the range of plus 2 to minus 4 percent of the optimum moisture content prior to placement in the trench.
 - 2) Place the first lift to a depth of 8 inches or $2/3$ the distance to the springline, whichever is greater.
 - 3) Do not exceed 1 foot in loose depth when placing succeeding lifts.
 - 4) Prevent the compaction equipment from damaging or moving the conduit.
 3. Fine Grading:
 - a. Unless indicated otherwise on the Contract Drawings, accurately grade the bottom of the trench or the top of the bedding, if it is required, to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for the portion of the pipe where depressions for joint making will be made as follows:
 - 1) After the bedding has been fine graded, dig depressions in the bedding to allow space to accommodate pipe bells, couplings, or other protuberances so the pipe shaft will rest on the prepared top of the bedding and the pipe will not be supported by any portion of the joint.
 - 2) Excavate depressions sufficiently wide to allow ample room for caulking, banding, bolting, or other appurtenances.



- 3) Excavate depressions only as necessary to permit accurate joint making and to ensure the pipe rests on the prepared bottom.
- 4) Excavate depressions in accordance with the recommendations of the joint manufacturer.

C. Dewatering:

1. Remove surface and ground water that accumulates in the trenches by pumping or another approved method at no increase in the Contract Price.

3.04 BACKFILLING

A. Backfill:

1. The type of backfill required is typically indicated on the Contract Drawings or in Phoenix Supplemental Standard Details for Public Works – Construction, particularly Drawing No. P1200.
 - a. If the trenching is in a Portland cement concrete street, provide aggregate base backfill, granular backfill, excavated “native” backfill, or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - 1) Provide permanent Portland cement concrete pavement replacement consisting of at least an 8-inch thick concrete pavement section over the backfill.
 - a) Construct the pavement section from Class A concrete as specified in Section 03300, Cast-In-Place Concrete.
 - b. If the trenching is in a bituminous concrete street that will not be repaved, comply with the following backfill and pavement requirements:
 - 1) For transverse trenches, defined as trenches 45 to 90 degrees from the street centerline, provide aggregate base backfill or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - a) Provide permanent bituminous concrete pavement replacement sections as indicated on the Contract Drawings over the backfill.
 - 2) For trenches parallel or less than 45 degrees from the street centerline, provide aggregate base backfill, granular backfill, excavated “native” backfill, or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - a) Provide permanent bituminous concrete pavement replacement sections as indicated on the Contract Drawings over the backfill.
 - 3) For trenches crossing a major street, collector street, or any other signalized intersection, provide aggregate base backfill, granular



- backfill, excavated “native” backfill, or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
- a) Provide permanent bituminous concrete pavement replacement sections as indicated on the Contract Drawings over the backfill.
 - c. If the trenching is in a bituminous concrete street that will be repaved, comply with the following backfill and pavement requirements:
 - 1) For transverse trenches, defined as trenches 45 to 90 degrees from the street centerline, provide aggregate base backfill or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - 2) For trenches parallel or less than 45 degrees from the street centerline, provide aggregate base backfill, granular backfill, excavated “native” backfill, or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - 3) For trenches crossing a major street, collector street, or any other signalized intersection, provide aggregate base backfill or controlled low strength material (CLSM) backfill between the granular bedding material below and the replacement pavement above.
 - 4) Provide temporary bituminous concrete pavement replacement for traffic control at intersections, and at existing partially paved areas where the pavement is not scheduled for immediate total removal and replacement.
 - 5) The Program/Project Manager may require temporary bituminous concrete pavement in areas where public safety and welfare warrants it.
 - d. If the trenching is in bituminous concrete pavement having a soil cement base course, concrete treated base course, or bituminous treated base course; either match the existing pavement structure including all courses, or replace the pavement structure with equivalent full depth bituminous concrete pavement.
 - 1) For computing the equivalent full depth bituminous concrete pavement required, assume 1 inch of bituminous concrete is equivalent to 3.25 inches of aggregate base course or 1.4 inches of soil cement, concrete treated base, or bituminous treated base.
 - 2) After computing the equivalent depth, round up the computed number to the next higher 1/2 inch; i.e. 6.15 inches rounds up to 6.5 inches.
 - e. If the trenching is in aggregate base course or decomposed granite, provide excavated “native” backfill compacted as specified and pavement replacement as indicated on the Contract Drawings.



- f. If the condition of existing pavement over an excavation does not justify using the previous backfill methods and pavement replacement, obtain written approval from the Program/Project Manager to provide excavated “native” backfill between the granular bedding material below and the replacement pavement above.
 - 1) Provide bituminous concrete pavement replacement sections as indicated on the Contract Drawings over the backfill.
2. Except when granular backfill material to be water settled is furnished, provide backfill having uniform moisture content throughout the material within the range of plus 2 to minus 4 percent of the optimum moisture content prior to placement in the trench.
 - a. The Program/Project Manager may require backfill placed but not complying with the specified moisture content requirements to be removed in order for the deficiencies to be corrected.
 - 1) Correct the deficiencies by blending excavated material with the backfill, or add or remove moisture prior to replacing it back into the trench, all at no increase in Contract Price
 - b. Controlled Low Strength Material (CLSM):
 - 1) In areas where future excavation into the backfill is anticipated or in areas of low loading such as in streets, in parking areas, behind retaining walls, and similar situations, controlled low strength material (CLSM) may be used to backfill the trench.
3. Backfilling Around Utilities:
 - a. Place backfill around utilities exposed during trench excavation in accordance with the methods specified for bedding.
 - b. If a utility structure is constructed within the open trench limits, backfill the utility structure in accordance with the requirements specified for the adjoining pipe.
 - c. If a utility structure is constructed outside the open trench limits, backfill the utility structure with aggregate base course compacted to 100 percent of the maximum density as determined by AASHTO T 99 and AASHTO T 191, or ASTM D 2922 and ASTM D 3017.
 - 1) If Methods A or B of AASHTO T 99 and AASHTO T 191 are used to determine the maximum density, correct the dry density using the rock correction procedure found in Standard Detail 190 in the MAG Uniform Standard Details for Public Works Construction.
4. As soon as possible after laying pipe in a trench that crosses streets, backfill the trench.
5. Where water consolidation is subsequently to be used, place backfill in lifts in accordance with Table 02316-3, unless the consolidation is accomplished using the jetting method.

**Table 02316-3 Maximum Depth of Backfill Lifts Prior to Settlement**

Trench Width	Depth of Backfill Lifts
18 to 24 inches	4 feet
25 to 36 inches	6 feet
Over 36 inches	8 feet

B. Compaction:

1. Compact the backfill as required for the type indicated on the Contract Drawings as follows:
 - a. If the type of compaction required is not indicated on the Contract Drawings, determine the type from Table 02316-4.
 - b. Unless indicated otherwise in the Contract Documents, thoroughly compact the trench backfill to not less than the densities indicated in Table 02316-4
 - 1) Determine the densities in accordance with the procedures specified in AASHTO T 99 and AASHTO T 191, or ASTM D 2922 and ASTM D 3017.
 - 2) If Methods A or B of AASHTO T 99 and AASHTO T 191 are used to determine the density, correct the dry density using the rock correction procedure found in Standard Detail 190 in the MAG Uniform Standard Details for Public Works Construction.

Table 02316-4 Trench Backfill Compaction Density (Minimum Percent)

Compaction Type⁽¹⁾ [Location]	Zones		
	From the Surface to 2 Feet Below the Surface	From 2 Feet Below the Surface to 1 Foot Above the Top of Pipe	From 1 Foot Above the Top of Pipe to the Bottom of the Trench
<u>Type I</u> – Under existing or proposed pavement, curb, gutter, sidewalk, or similar construction included in the Contract; or where any part of the trench excavation is within 2 feet of foregoing items.	100	95	95



Table 02316-4 Trench Backfill Compaction Density (Minimum Percent)			
Compaction Type ⁽¹⁾ [Location]	Zones		
	From the Surface to 2 Feet Below the Surface	From 2 Feet Below the Surface to 1 Foot Above the Top of Pipe	From 1 Foot Above the Top of Pipe to the Bottom of the Trench
Type II ⁽²⁾ – On utility easements, streets, roads, or alley rights-of-way outside the limits for Type I.	95	95	95
Type III – Around structures or exposed utilities.	95	95	95
<p>1. The Compaction Type indicated on the Contract Drawing will govern, but if no Compaction Type is indicated there, determine the Type for the location as specified in Table 02316-4.</p> <p>2. If Type II Compaction is indicated on the Contract Drawings, but trench widths are increased beyond the widths indicated on the Contract Drawings and fall within the 2-foot limit specified above for Type I Compaction, then the compaction required for that portion of the backfill is Type I.</p>			

2. Mechanical Compaction:
 - a. Where mechanical consolidation is to be used, demonstrate the method and equipment proposed to the Program/Project Manager within a test section, and obtain the approval of the Program/Project Manager before using the method and equipment to perform the Work.
 - 1) Do not change approved methods and equipment without the prior approval of the Program/Project Manager.
 - b. Do not use mechanical consolidation to compact lifts exceeding 1 foot without the written approval of the Program/Project Manager.
 - c. Mechanical consolidation requires hand work and/or mechanical methods using equipment such as rollers, pneumatic tampers, hydro-hammers, or other devices which secure uniform and required density without injuring pipe or other structures in the trench.
3. Water Consolidation:
 - a. If water consolidation, either jetting or flooding, is permitted and used, and the surrounding material does not permit proper drainage, provide a sump and a pump at the downstream end of the trench to remove accumulated water.



- 1) Where Type I compaction is required for non-granular backfill material, water consolidation is not permitted.
 - b. Jetting:
 - 1) Use jetting for consolidating all conduit bedding.
 - a) Establish each lift depth so the conduit being place is not floated.
 - b) For conduit larger than 24 inches in diameter, the first lift may not exceed the springline of the conduit.
 - 2) Provide jets consisting of 1-1/2 inch diameter pipe sufficiently long to reach the bottom of the lift being settled, and having an adequate water supply hose attached.
 - 3) Throughout the length of the trench, insert the jets transversely across the trench at 6-foot intervals, staggering jet locations so they are offset to the jet locations on the other side of the trench.
 - 4) Supply water to the jets at a pressure not less than 30 psi.
 - 5) Working from top to bottom, slowly force the jets down to the bottom of the trench or the top of the previously jetted lift, and level and completely saturate the entire lift.
 - c. Flooding:
 - 1) Unless it is specifically authorized in the Specifications or by Change Order, flooding is unacceptable as a water consolidation method.
 - 2) If flooding is authorized, inundate the entire lift with water and then puddle the lift with poles and bars to ensure the entire lift is saturated.
 - d. If water consolidation is not permitted or results in inadequate compaction, compact the material using mechanical consolidation.
- C. Interface with Other Work:
1. Control grading in the vicinity of trench excavation to prevent surface water from flowing into the trenches.
 2. Earth Forms:
 - a. Concrete placed for cast-in-place utility structures in trenches may be placed directly against the excavated surface, provided that the faces of the excavation are firm and unyielding, and are all at points outside the structure lines shown on the Contract Drawings.
 - 1) If the native material will not stand without sloughing, or if precast structures are to be constructed, over-excavate the trench sufficiently to allow the structure to be properly constructed.

3.05 REPAIR

- A. Repair damage to existing improvements and/or conduits and structures in trenches resulting from water consolidation of bedding and/or backfill at no increase in Contract Price.



3.06 RESTORATION

A. Grading:

1. Grade the area adjacent to backfilled trenches and structures leaving the area neat and in a satisfactory condition as determined by the Program/Project Manager.

B. Pavement Replacement:

1. Resurface the streets, alleys, driveways, sidewalks, curbs, and other similar paved areas where the surface has been broken into or otherwise damaged by the installation of the new Work.
 - a. Resurface the areas in kind, or as otherwise indicated on the Contract Drawings.
2. Prior to the placement of bituminous or Portland cement concrete over trenches, the Program/Project Manager may require the trench or portions of the trench to be load tested for stability using the Contractor's equipment.
 - a. Prior to the placement of bituminous or Portland cement concrete over trenches, correct unstable areas identified by the Program/Project Manager at no increase in Contract Price.
3. Temporary Pavement Replacement:
 - a. Immediately after backfilling and compacting the backfill for trenches that have been cut through existing pavement, install temporary pavement or the first course of permanent pavement replacement so the finished surface of the temporary pavement is flush with the adjacent pavement.
 - 1) In lieu of immediately placing a single course permanent replacement or the first course of 2 course pavement construct temporary pavement during the same shift in which the backfill to be covered is completed.
 - b. Provide cold mix bituminous concrete placed in 2 inch increments, and compacted with a roller having a contact pressure of at least 60 psi.
 - 1) Compact each layer to 96 percent of the laboratory compacted density for like materials.
 - 2) If roller compaction is impractical in an area, small vibrating rollers or vibrating plate compactors may be used provided the specified compaction is obtained.
4. Permanent Pavement Replacement:
 - a. Prior to placing concrete for permanent pavement replacement, compact the trench backfill to the specified density, and place the required aggregate base course.
 - 1) Do not allow placement of bituminous concrete pavement replacement single course or base course to lag more than 600 feet behind placement of its aggregate base course.



- b. For cuts generally parallel to the street centerline and greater than 50 feet long, provide pavement replacement consisting of 2 bituminous concrete courses as specified herein.
- c. For cuts generally parallel to the street centerline and less than 50 feet long, for transverse cuts, for bell holes, and for similar small areas, provide a single course pavement patch.
 - 1) Match the gradation and thickness of the existing pavement.
 - 2) Compact the single course to the same density as for bituminous concrete pavement using a vibratory roller.
- d. For permanent pavement replacement of deep lift asphalt concrete, where the existing pavement consists of both asphalt concrete base and wearing courses, provide the base course replacement in lifts not exceeding 6 inches in compacted thickness to within 1/2 inch of the finish grade.
- e. Placing and Compacting Pavement Replacement:
 - 1) For trenches 6 feet wide or wider, place all permanent pavement replacement courses using self-propelled spreading and compacting equipment.
 - a) If the trenches are from 6 to 8 feet wide, use compacting, spreading equipment not wider than 8 feet.
 - 2) Except for surface courses, compact permanent pavement replacement courses to 1-1/2 inches thick or more.
- f. Single Course:
 - 1) Where providing single course pavement replacement, provide either a Type C-3/4 Surface Course bituminous concrete mix or a Type D-1/2 Surface Course bituminous concrete mix, and finish the course as directed by the Program/Project Manager.
- g. Base Course:
 - 1) Place a bituminous concrete base course consisting of a Type C-3/4 Base Course mix.
 - 2) If the base course is placed with non-compactive equipment, immediately roll the material with a pneumatic-tired roller to provide a thickness of not less than 2 inches.
- h. Surface Course:
 - 1) Over the base course, place a bituminous concrete surface course of sufficient depth to provide the total compacted thickness required of the 2 courses, but not more than 1 inch deep.
 - 2) Place a bituminous concrete surface course complying with the requirements for Type D-1/2 Surface Course to match the existing surface, flush with the existing pavement, using means that result in a surface texture satisfactory to the Program/Project Manager.
 - 3) Except where a trench crosses a signalized intersection, do not place the surface course sooner than 2 weeks after placing the base course.



- 4) Where a trench crosses a signalized intersection, place the surface course within 48 hours after placing the base course, or provide just a single course.
- i. Seal Coat:
 - 1) For cuts greater than 600 feet long, seal coat the entire area from the edge of pavement or lip of the gutter to the centerline of the street with asphalt overlay, slurry seal, microsurfacing, or a modified asphalt emulsion as directed by the Program/Project Manager.
 - a) Slurry seals are not allowed on major and collector streets.
5. Adjust new and existing manholes, valves, survey monuments, clean outs, and similar items to grade as directed by the Program/Project Manager.
 - a. Prior to resetting frames, remove all loose material from the excavation site and the interiors of utility structures.
 - b. Do not allow debris to enter sanitary or storm sewers.
 - c. Adjust manhole frames in accordance with Detail No. 422 in the MAG Uniform Standard Details for Public Works Construction, except extend the concrete color up to the finished grade.
 - d. Adjust water valves, survey markers, and sewer clean out frames for in accordance with Detail No. P1270 and Detail No. P1391 in the Phoenix Supplemental Standard Details for Public Works – Construction.
 - e. Remove asphalt material and aggregate from metal lids and covers encountered using a method approved by the Program/Project Manager.
- C. Irrigation Facilities:
 1. Restore irrigation ditches, dikes, headgates, pipe valves, checks, and similar facilities damaged or removed by the Contractor to their original condition or better at no increase in Contract Price.

3.07 CLEANING

- A. Clean up after trenching so the Site is in a neat condition acceptable to the Program/Project Manager.
- B. Excess Material:
 1. Haul excess excavated material from the Site, and legally dispose of it.
- C. Waste Management:
 1. Immediately following demolition of concrete and pavement surfacing material demolished to allow trenching to commence, haul the demolished material from the Site.
 - a. Haul temporary pavement surfacing material that has been demolished from the Site immediately following the demolition.



2. Properly dispose of demolished concrete and pavement surfacing material at no increase in Contract Price.
 - a. Do not use concrete and pavement surfacing material as backfill.

3.08 MAINTENANCE

- A. Maintain temporary pavement in a safe and reasonably smooth condition until the final compaction and, if required, pavement replacement is performed.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/6/2017	N/A	All	First edition.





SECTION 02339

SUBGRADE PREPARATION



Roadway Joint Sealant
Sitewide Approval

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for preparation of natural or excavated areas prior to the placement of sub-base material, pavement, curbs and gutters, driveways, sidewalks, or other structures.
- B. Related Requirements:
 - 1. Section 01400 - Quality Requirements.
 - 2. Section 02231 - Clearing and Grubbing.
 - 3. Section 02300 – Earthwork.

1.02 REFERENCES

- A. Definitions:
 - 1. Unsuitable Material: Material that contains organic matter, soft spongy earth, or other matter of similar nature so that compaction to the specified density is unobtainable.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO T 99 – Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 - b. AASHTO T 191 - Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
 - c. AASHTO T 224 - Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test.
 - 2. Arizona Revised Statutes (ARS):
 - a. Chapter 2, Article 6.3, Underground Utilities, ARS 40-360.21 through 32.
 - b. Chapter 2, Article 6.4, Overhead Powerline Safety Law, ARS 40-360.41, 45.
 - 3. ASTM International (ASTM):
 - a. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - b. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).



- c. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- 4. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications for Public Works Construction:
 - 1) MAG Section 211 – Fill Construction.
 - 2) MAG Section 301 – Subgrade Preparation.
 - b. MAG Uniform Standard Details for Public Works Construction.
 - 1) Detail No. 190 Rock Correction Procedure for Maximum Density Determination.
- 5. Maricopa County:
 - a. Air Quality Department:
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit.
 - 3) Dust Control Logs.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
 - 2) Regulation III – Control of Air Contaminants:
 - a) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
 - b) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.
- 6. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.



- 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
- b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.
2. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.
 - a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
 - b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections required by this Section, the Phoenix Sky Harbor International Airport will employ a Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements.

1.05 SITE CONDITIONS

A. Ambient Conditions:

1. Do not perform excavating, backfilling, or compacting operations when either weather conditions or the condition of the materials are such, in the opinion of the Program/Project Manager, that the work cannot be performed satisfactorily.
2. Dust Control:
 - a. In accordance with Rule 200 of the Maricopa County Air Pollution Control Regulations, a Dust Control Permit issued by the Maricopa County Air Quality Department is required for Sites where more than 0.1 acre (4356 square feet) of soil will be disturbed.
 - 1) If a Dust Control Permit is required for this Contract, in accordance with the requirements of Section 01425, Regulatory Requirements, follow the instructions in the Maricopa County Air Quality Department's "Guidance for Dust Control Permit for Application" and file the "Application for Dust Control Permit", which requires including a Dust Control Plan with the Application, and pay the permit fees in accordance with Maricopa County Air Pollution Control Regulation Rule 280.
 - a) At the Pre-Construction Conference, submit the approved Dust Control Plan to the Program Manager for information.



- (1) Include a description of equipment, personnel, and methods required for controlling dust.
- (2) Include a method for keeping public thoroughfares free of mud, dust, and debris at all times.
- b) Comply with the requirements of the Maricopa County Dust Control Permit and air pollution control requirements, particularly Maricopa County Air Pollution Control Regulation Rules 310 and 310.01.
 - (1) Rule 310 requires maintaining daily logs recording the actual implementation of control measures identified in the Dust Control Permit.
- 2) Maricopa County Air Quality Department Dust Control Permits must be renewed annually.
- 3) Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.
- b. Provide effective dust control measures on the Site to prevent the spread of dust during earth moving operations.
- c. Thoroughly moisten excavation areas by dampening the soil, or employ other similar methods as approved by the Program/Project Manager.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Notify the Program/Project Manager of unexpected subsurface conditions, and discontinue working in the affected area until notified to resume work.
- B. Pre-Installation Testing:
 1. If it is evident that the subgrade is pumping at any time prior to placing overlying material onto the subgrade, the Program/Project Manager may at no increase in Contract Price require proof rolling with a pneumatic-tire roller or other approved equipment in order to identify the limits of the unacceptable area.
 2. After completion of excavations other than utility excavations, and prior to scarification and compaction of the subgrade, proof-roll the excavation surface to detect soft or loose zones.
 - a. Notify the Program/Project Manager if any soft or loose zones are encountered during the proof-rolling.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Exercise extreme caution to prevent debris from falling into manholes or other structures.
 - a. In the event that debris should fall into a structure, remove it immediately.
- B. Surface Preparation:
 - 1. With the exception of areas where new construction is required and compacted fills have been constructed, adjust the moisture content of the subgrade to that required for compaction by adding water, by adding and blending in dry suitable material, or by drying the existing material as required.
 - a. Maintain the proper subgrade moisture content until the subgrade is compacted and the overlying material is placed.
- C. Demolition/Removal:
 - 1. Strip and properly dispose of unsuitable material in the area of the required subgrade including removing existing pavement and obstructions such as stumps, roots, rocks, and similar items from the subgrade area.
 - a. Clear and grub unpaved subgrade area in accordance with the requirements of Section 02231, Clearing and Grubbing.
 - b. Demolish existing pavement where indicated on the Contract Drawings, and properly dispose of demolition debris off-site unless otherwise allowed by the Program/Project Manager.
 - 1) Remove existing pavement under proposed median islands

3.03 RELATIVE COMPACTION

- A. Remove and replace soft, loose, and disturbed materials; and compact the replaced material as directed by the Program/Project Manager.
 - 1. If soft or loose zones are found under proposed slab, pavement, or foundation areas, excavate the soft or loose material to a depth reviewed in advance by the Program/Project Manager, then fill with structural fill as specified in Section 02300, Earthwork, and compact as specified for such fill.
- B. After adjusting the moisture content to that required for compaction, scarify and loosen the subgrade to a depth of at least 6 inches.
 - 1. Below future slabs, pavements, and foundations, scarify the exposed native and pre-existing fill subgrade soils to a depth of 8 inches
 - 2. In areas where fill material is required, a layer of approximately 3 inches of the fill material may be spread and compacted with the subgrade material to provide a better bond.



- C. Compact the material to the relative density specified.
1. Construct the cut and fill areas to achieve a uniform soil structure having the minimum dry density specified in Table 02339-1 when the compaction is tested in accordance with Method A in AASHTO T 99 and AASHTO T 191, or with ASTM D 2922 and ASTM D 3017.
 - a. Adjust the minimum dry density percent obtained from AASHTO T 99 in accordance with the coarse particle correction procedures specified in AASHTO T 224 for maximum density determination, to compensate for the rock content larger than that which will pass a Number 4 sieve.

Table 02339-1 Minimum Dry Density Required	
Location	Minimum Dry Density
Subgrade under pavement	100 percent
Subgrade under curbs, gutters, and sidewalks	95 percent

3.04 GRADING IN AREAS NOT TO BE PAVED

- A. Where grade only is called for on the Contract Drawings, grade the area to meet the tolerances for the subgrade where sub-base or base material is to be placed.
- B. Construct the surface to a straight grade from the finished pavement elevations shown on the Contract Drawings to the elevation of the existing ground at the extremities of the area to be graded.

3.05 GRADING IN AREAS TO BE PAVED

- A. Where pavement or structures are called for on the Contract Drawings, grade the area in an orderly sequence, placing base course directly following the grading.
 1. Do not allow grading operations to precede base course placement by more than 1200 feet unless otherwise specifically approved by the Program/Project Manager.
 2. At the end of each day's operations, place the first lift of base course no more than 300 feet behind the finished subgrade area.
 - a. Do not allow drop-offs on opposite sides of pavement at the same time.
- B. When excavating for concrete work, such as curb, gutter, or sidewalk, place the excavated material in uniform windrows that do not interfere with property access or traffic flow in streets.



3.06 SUBGRADE TOLERANCES:

- A. Subgrade upon which pavement, sidewalk, curb and gutter, driveways, or other structures are to be directly placed may not vary more than 1/4 inch from the specified grade and cross-section.
- B. Subgrade upon which sub-base or base material is to be placed may not vary more than 3/4 inch from the specified grade and cross-section.
- C. Variations within these specified tolerances must be compensating so that the average grade and cross-section specified are met.

3.07 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Relative Compaction Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will test the relative density of the subgrade compaction performed in accordance with Method A in AASHTO T 99 and AASHTO T 191, or with ASTM D 2922 and ASTM D 3017.
 - b. Acceptance Criteria:
 - 1) Subgrade compaction having the at least the minimum dry density specified in Table 02339-1 is acceptable.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.
1	12/26/20017	N/A	Table 02339-1	Density under sidewalk, etc. changed to 95%.





SECTION 02361

TERMITE CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for poisoning the soil below slab-on-grade construction to provide horizontal and vertical barriers against attack by subterranean termites.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. FHA: United States Federal Housing Administration.
 - 2. OPM: State of Arizona Office of Pest Management.
 - 3. VA: United States Veterans Administration.
- B. Definitions:
 - 1. Toxicant: A toxic agent, especially one for insect control that kills rather than repels.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. State of Arizona:
 - a. Arizona Revised Statutes (ARS):
 - 1) ARS 32-2313 – Business License; Renewal; Financial Security; Definition.
 - b. Office of Pest Management (OPM):
 - 1) Rules and Regulations.
 - 3. United States Government:
 - a. United States Department of Agriculture (USDA):
 - 1) Forest Service:
 - a) USDA Home and Garden Bulletin 64 – Subterranean Termites-Their Prevention and Control in Buildings.
 - b. United States Environmental Protection Agency (EPA):
 - 1) United States Code (U.S.C.):
 - a) 7 U.S.C. Section 136-136y.
 - (1) Federal Insecticide, Fungicide, and Rodenticide Act, Public Law 100-532, as amended.



(2) Pesticide Registration Improvement Act of 2003, Public Law 108-199, as amended.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Do not apply toxicants without providing at least 24 hours prior notice to the Program/Project Manager and a representative of the City of Phoenix to enable their presence during application.
 - 2. Give sufficient notice to the Applicator prior to placing the concrete to permit applications to be made.
- B. Sequencing:
 - 1. If the concrete is not placed within 24 hours after the time of treatment, re-treat the area at no increase in Contract Price.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Samples:
 - 1) Sample of the termicide.
 - b. Delegated Design Submittals:
 - 1) Area and lineal calculations for the toxicants.
 - c. Qualification Statements:
 - 1) Applicator's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's instructions for the toxicants.
 - b. Manufacturer's Reports:
 - 1) Material safety data sheets (MSDS) for the toxicants.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Bonds:
 - 1) Proof of Applicator's surety bond.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:



1. Comply with the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, and the Pesticide Registration Improvement Act of 2003 as amended.
2. Comply with the Rules and Regulations of the State of Arizona Office of Pest Management (OPM).
 - a. Immediately after completion of the treatment, post a tag at the Site as prescribed by the Rules and Regulations of the State of Arizona Office of Pest Management (OPM).
 - b. Placing footing or floor slab concrete is not permitted until the information on the tag described herein has been reconciled with the requirements of this Specification by the City of Phoenix's representative.
3. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Qualifications:

1. Applicator's Qualifications:
 - a. Employ a pesticide applicator licensed, certified by, and registered with the State of Arizona Office of Pest Management (OPM).
 - b. Submit the Applicator's qualifications to the Program/Project Manager for approval.

C. Site Samples:

1. Prior to the initial application of termicide, submit a small, uncut, labeled Sample of the termicide to the Program/Project Manager for use as a control sample.
 - a. During each application, a field sample may be taken from the application nozzle by the Program/Project Manager or City Representative for testing comparison.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver toxicants to the Site in sealed and labeled containers bearing the manufacturer's instructions and precautions for handling and use of the material.
2. Do not bring to the Site, or use, any emulsion of a previous application.

B. Storage and Handling Requirements:

1. Store toxicants according to the directions on the manufacturer's label.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not make a treatment when the soil or fill is excessively wet.



- a. If rain or other water is allowed on the treated area, re-treat the treated area.

1.08 WARRANTY/BOND

A. Special Warranty:

1. After completion of treatment, and as a condition of final acceptance, submit an Applicator's written guarantee to the Program/Project Manager and the City of Phoenix that provides the following:
 - a. Assurance the application was made at the required concentration rates using methods complying with manufacturer's label and this Specification.
 - b. A guarantee of the effectiveness of the treatment for a period of 10 years from the date of the Final Acceptance at no increase in Contract Price.
 - c. Draw the guarantee in favor of the City of Phoenix.
 - 1) Pre-printed Federal Housing Administration (FHA) or Veterans Administration (VA) guarantee forms are unacceptable.
2. The City of Phoenix reserves the option to renew the termite protection on an annual basis after the expiration of this guarantee.

B. Bond:

1. Prior to the start of treatment, submit proof that the Applicator holds a surety bond as specified in ARS 32-2313 to the Program/Project Manager and the City of Phoenix for approval.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Manufacturer List:
 - a. FMC Corp., Dragnet SFR Termiticide/Insecticide 7/02 (permethrin), www.fmc.com.
 - b. Bayer Environmental Science, Premise, www.bayerprocentral.com.
2. Substitution Limitations:
 - a. No other substitutions will be approved.

B. Regulatory Requirements:

1. Provide a termite soil treatment chemical registered with the United States Environmental Protection Agency as provided in the Federal Insecticide, Fungicide, and Rodenticide Act as amended, and the Pesticide Registration Improvement Act of 2003; and registered with the Office of the Arizona State Chemist.

C. Materials:

1. Provide one of the soil treatment products specified in Paragraph 2.01.A



2. Prior to application, submit the following to the Program/Project Manager for information:
 - a. Material safety data sheets (MSDS) for the toxicants.
 - b. Manufacturer's instructions for the toxicants.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Prior to treatment, inspect the subgrade, forms, and reinforcing steel, if applicable.

3.02 APPLICATION

- A. Perform the Work of this Section in accordance with the Rules and Regulations of the State of Arizona Office of Pest Management (OPM), the toxicant manufacturer's label, USDA Home and Garden Bulletin 64, and this Section.
- B. Toxicant Mixing:
 1. Mix toxicants onsite in an empty container or tank.
 2. Mix toxicants in accordance with the manufacturer's instructions in the presence of the Program/Project Manager and a representative of the City of Phoenix, and equaling the quantities in prescribed concentrations for coverage in approved areas to receive treatment.
 - a. Submit area and lineal calculations for the toxicants to the Program/Project Manager for approval.
 3. Mix toxicants at the highest percentage concentration allowed by the label for the type of application required to form a uniform emulsion.
- C. Areas of Application:
 1. Establish horizontal barriers under the entire surface of the slabs-on-grade, except sidewalks; and establish barriers on the sides and bottom of foundation footings.
 - a. Treat sidewalks, entrance slabs, and other slabs abutting the structure for a distance not less than 3 feet extending from and adjacent to the building.
 2. Establish vertical barriers around the base of foundations, plumbing lines, foundation walls, below grade walls, along expansion/contraction and/or cold joints, at all slab penetrations, and wherever required by the manufacturer's instructions.
 3. If these methods of treatment are not possible, rodding and/or trenching may be permitted only if under the inspection of the Program/Project Manager and a representative of the City of Phoenix.



- a. Extend rodding and/or trenching from the finished floor to the top of the footings, and take special care not to disturb applied waterproofing and other buried facilities.
- b. Perform rodding and/or trenching applications in strict accordance with the manufacturer's instructions.
4. Take particular care when treating "critical areas" as described on the manufacturer's label.

D. Application Methods:

1. Apply the toxicant emulsions using methods complying with requirements specified on the manufacturer's label.
2. Do not disturb the treated areas prior to or during concrete placement.
 - a. Re-treat those areas which are disturbed after treatment is completed according to the manufacturer's directions and at no increase in the Contract Price.

3.03 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Inspections:
 - a. Permit the Program/Project Manager and a representative of the City of Phoenix to inspect the application, take multiple Samples for testing, and verify the rate and volumes of soil and emulsions.

B. Non-Conforming Work

1. If evidence of subterranean termite activity and/or damage to the structure resulting from such activity is discovered within the guarantee period, treat to stop the infestation of affected areas.
 - a. Upon the third recurrence of subterranean termites in the same structure within a 5 year period from the date of Final Acceptance, completely re-treat the building as specified in USDA Home and Garden Bulletin 64.
 - b. Repair all damage caused by infestation and/or re-treatment at no increase in Contract Price.

3.04 WASTE MANAGEMENT

- A. Remove excess toxicant materials safely from the Site.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 02373

RIPRAP AND ROCK LINING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for furnishing and placing a cover of riprap onto slopes subject to erosion in order to permanently stabilize the slopes.
 - a. Provide the type of riprap indicated on the Contract Drawings, either plain or grouted stone riprap, or sacked concrete riprap.
 - b. Provide riprap to the depths and slopes indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 02231 - Clearing and Grubbing.

1.02 REFERENCES

- A. Definitions:
 - 1. d₅₀: A designation used to specify the size range of a stone mixture used for graded riprap that is based on a hypothetical "spherical design diameter", d, specified for the stone, and listing a percentage of the stones in the mixture required to have a weight less than the weight of a stone of diameter d.
 - a. For example, d₅₀ refers to a mixture of stones in which 50 percent of the stones would weigh less than the hypothetical stone whose "spherical design diameter", d, is specified; and d₈₅ refers to a mixture of stones in which 85 percent of the stones would weigh less than the hypothetical stone whose "spherical design diameter", d, is specified.
 - 2. Grouted Riprap: Slope protection placed on a stable and properly prepared slope and consisting of a free draining subbase or bedding layer under a layer of sound, durable stone bonded together by a mixture of cementitious materials, water, aggregates, and admixtures.
 - 3. Minimum Average Roll Value (MARV): A statistical measure used to evaluate geotextile properties derived as follows:
 - a. The MARV for a group of geotextile rolls is determined by calculating the statistical value such that 2.5 percent of the test results derived from tests performed on test samples selected from the batch of rolls in question are less than the mean value of all test results for that batch minus 2 standard deviations.



4. Riprap: A permanent, erosion-resistant ground cover of large, loose, angular stone with filter fabric or granular underlining.
5. Well-Graded Mixture: A mixture of stones whose largest stone size is 1.5 times the d_{50} size, but though composed primarily of larger stone sizes has a sufficient mixture of other sizes to fill progressively smaller voids between the stones.

B. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. Standard Specifications for Transportation Materials and Methods of Testing and Sampling:
 - 1) AASHTO M 43 - Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
 - 2) AASHTO M 80 - Standard Specification for Coarse Aggregate for Portland Cement Concrete.
 - 3) AASHTO T 99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 - 4) AASHTO T 191 - Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
2. American Society for Testing and Materials (ASTM):
 - a. ASTM C 131 - Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - b. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - c. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.
 - d. ASTM D 448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - e. ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - f. ASTM D 2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - g. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - h. ASTM D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
 - i. ASTM D 4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity.
 - j. ASTM D 4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - k. ASTM D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.



- I. ASTM D 4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - m. ASTM D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - n. ASTM D 4873 - Standard Guide for Identification, Storage, and Handling of Geotextiles.
 - 3. City of Phoenix (COP):
 - a. The Code of the City of Phoenix, Arizona.
 - 1) Chapter 32C - Storm Water Quality Protection, Sections 100 through 106.
 - 4. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Details for Public Works Construction.
 - 1) Detail No. 190 Rock Correction Procedure for Maximum Density Determination.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.
 - 2. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.
 - a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
 - b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Geotextile filter fabric.
 - 2) Geotextile seam thread.
 - b. Samples:
 - 1) Samples of riprap rock at the Site.
 - c. Certificates:
 - 1) Cement manufacturer's Certificate of Compliance.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Geotextile manufacturer's recommendations regarding exposure of geotextile to ultraviolet radiation.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. The Work of this section is subject to approvals before it can be put into service and accepted.
 - a. Arizona Pollutant Discharge Elimination System (AZPDES) Permits:
 - 1) In all areas of Arizona except Indian Country, the National Pollutant Discharge Elimination System (NPDES) program is administered as the Arizona Pollutant Discharge Elimination System (AZPDES).
 - 2) Comply with the requirements of all AZPDES permits applicable to the Contract.
 - a) Most stormwater discharges are permitted under various general permits; however, an individual permit is required when the general permit requirements do not accurately represent the activity at a facility and a permit is customized to the Site.
 - b) AZPDES Construction General Permit (AZG2008-001):
 - (1) Generally, stormwater and non-stormwater discharges resulting from small construction activities and that are not potential pollutant sources are regulated under the Arizona Pollutant Discharge Elimination System (AZPDES) Construction General Permit (AZG2008-001).
 - c) In accordance with Chapter 32C of The Code of the City of Phoenix, Arizona, any person applying for authorization, permission, or a permit to construct improvements or conduct activities on non-residential property that have the reasonable potential to affect storm water must prepare a detailed written storm water management plan for the management of the



volume, velocity, and quality of storm water that has the reasonable potential to be released offsite.

- b. If the Contract impacts water bodies, a Clean Water Act, Section 404 permit will be required from the U.S. Army Corps of Engineers.

B. Certifications:

1. Cement Manufacturer's Certificate of Compliance:

- a. Submit a manufacturer's Certificate of Compliance identifying the cement and certifying that the cement provided for the Work of this Section complies with the specified requirements.

C. Site Samples:

1. Provide 2 Samples of riprap rock at the Site for each type of riprap, each Sample weighing at least 2 tons and having the gradation specified for the type of riprap represented by the Sample.
 - a. One Sample of each type of riprap may be incorporated into the Work, the second Sample will be used as a reference to judge the gradation of riprap stone subsequently supplied.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Prevent segregation of riprap stone and granular materials during transportation, dumping, and off-loading.
2. Identify and handle geotextile filter fabric in accordance with the requirements of ASTM D 4873.
 - a. Label each roll of geotextile with the manufacturer's name, product identification, roll dimensions, lot number, and date of manufacturer.
3. Verify from label information that the geotextile delivered to the Site is the same as specified.
4. Deliveries of riprap stone will be visually compared to the approved field sample as a reference to judge the acceptability of the gradation, or analyzed using the Wolman count method to determine the acceptability of the size distribution of the riprap stone.
 - a. Remove rejected riprap stone from the Site, and properly dispose of it offsite.
5. Deliver cement to the Site in original unopened sacks filled at the mill and bearing the name or brand of the manufacturer.
 - a. Clearly identify the type of cement and the weight of the cement in the sack on each sack.

B. Storage and Handling Requirements:

1. Do not drag the geotextile rolls, or lift the geotextile by one end, or drop the geotextile.
2. Store geotextile filter fabric in accordance with the requirements of ASTM D 4873.



- a. Do not expose geotextile to sunlight prior to placement.
3. Store cement so that it is accessible to be inspected and identified.
4. Protect cement against damage from moisture.

PART 2 PRODUCTS

2.01 DESCRIPTION:

- A. Riprap consists of a substantial rock cover placed on top of a thin layer of filter material, and is to be located on slopes subject to erosion in order to permanently stabilize the slopes where shown on the Contract Drawings.
 1. The filter material may consist either of geotextile or granular material.
 2. Additional bedding material may be placed between the riprap and filter materials to cushion and protect the filter material during installation of the riprap.

2.02 MATERIALS

- A. Bedding Stone:
 1. Provide bedding stone that conforms to the requirements specified in AASHTO M 80.
 2. Provide bedding stone sizes in accordance with the size requirements specified in AASHTO M 43 and indicated on the Contract Drawings.
- B. Concrete:
 1. Provide concrete as specified in Section 03300, Cast-In-Place Concrete, except as modified herein.
 - a. Aggregates:
 - 1) Pitrun material at least 80 percent of which is capable of passing a 1-1/2 inch square mesh screen is an acceptable aggregate.
 - 2) Aggregate does not need to be segregated by primary sizes.
 - b. Portland Cement Content:
 - 1) Provide concrete containing 376 pounds of Portland cement per cubic yard.
 - c. Water:
 - 1) Provide water sufficient to produce a mixture having a slump of 3 to 5 inches when tested in accordance with the requirements of ASTM C 143/C 143M.
- C. Geotextile Filter Fabric:
 1. Provide either woven or non-woven geotextile filter fabric that exhibits the properties specified in Table 02373-1 for the class indicated.
 - a. Woven Geotextile Fabric:
 - 1) Provide non-filament woven geotextile.
 - b. Non-Woven Geotextile Fabric:



- 1) Needle-punched geotextile fabrics are acceptable and may be provided, but spun-bond and slit-film fabrics are unacceptable.
- 2) Mass Density: 12 ounces, minimum, per square yard.

Table 02373-1 Geotextile Filter Fabric Properties

Property	Test	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
Elongation	ASTM D 4632	<50 Percent			>50 Percent		
Grab strength	ASTM D 4632	>315 lbs	>250 lbs	>180 lbs	>200 lbs	>160 lbs	>110 lbs
Sewn seam strength	ASTM D 4632	>270 lbs	>220 lbs	>160 lbs	>180 lbs	>140 lbs	>100 lbs
Tear strength ⁽¹⁾	ASTM D 4533	>110 lbs	>90 lbs	>70 lbs	>110 lbs	>90 lbs	>70 lbs
Puncture strength	ASTM D 4833	>110 lbs	>90 lbs	>70 lbs	>110 lbs	>90 lbs	>70 lbs
Apparent opening size	ASTM D 4751	Number 40 U.S. Standard sieve, maximum					
Permittivity & permeability	ASTM D 4491	4 times greater than the base soil, minimum					
Degradation by ultraviolet light	ASTM D 4355	Greater than 50 percent of the sample's strength retained after 500 hours of exposure, minimum					
1 For woven monofilament geotextiles, the Minimum Average Roll Value (MARV) is 55 pounds.							

2. The geotextile classes required for the indicated permanent erosion control applications are as follows:
 - a. Class 1: For harsh or severe installation conditions where there is a greater potential for geotextile damage, such as when placement of riprap must occur in multiple lifts, when drop heights exceed 1 foot, or when repeated vehicular traffic is anticipated on the installation.
 - b. Class 2: For installation conditions where placement is in regular, single lifts, and vehicular traffic on the installation is anticipated to be minimal, or when individual rocks are placed using a clamshell, orange-peel grapple, or specially equipped hydraulic excavator with drop heights of less than 1 foot.
 - c. Class 3: For the least severe installation conditions where drop heights are of less than 1 foot onto a bedding layer of select sand, gravel, or other select imported material.
3. Geotextile Seam Thread:
 - a. Provide ultraviolet radiation resistant, high-strength polypropylene or polyester thread suitable for stitching geotextile strips together at seams.



4. Submit the geotextile manufacturer's Product Data for the geotextile filter fabric and seam thread to the Program/Project Manager for approval, and submit the manufacturer's recommendations regarding time limits for their exposure to ultraviolet radiation to the Program/Project Manager for information.

D. Granular Filter Material:

1. Provide granular filter material that consists of hard, durable bank or crushed gravel, stone, or slag mixed or blended with suitable filler materials to provide a uniform mixture.
 - a. Provide granular filter material free from vegetation or organic matter, free from lumps, and free from excessive quantities of clay or other objectionable or foreign substances so that less than 10 percent of the material by weight is deleterious.
2. Gradation:
 - a. Provide granular filter material having the gradation specified in Table 02373-2.

Table 02373-2 Gradation of Granular Filter Material	
Sieve Size	Percent Passing
2 Inch	100
Number 4	15 to 60
Number 100	0 to 30

E. Riprap Stone:

1. Riprap Stone Properties:
 - a. Provide sound, hard, field or quarry stone that will not disintegrate on exposure to water and weathering, that has no earthy odor, and that does not absorb water easily.
 - 1) Provide riprap rock that only breaks with difficulty; and that is not composed of appreciable amounts of clay.
 - a) Shales, mudstones, and claystones are unacceptable.
 - 2) Provide riprap rock that does not have closely spaced discontinuities, such as seams, joints, or bedding planes.
 - b. Waste concrete is acceptable riprap stone if it is free of coatings, and if it meets the specified size requirements.
2. Riprap Shape:
 - a. Provide riprap having shapes which will form a stable protection structure of the required depth.
 - 1) Angular shaped riprap stone is acceptable for use in riprap having any slope.
 - 2) Rounded riprap stone is unacceptable for use in riprap having a slope steeper than 2:1 unless it is grouted.



- 3) Flat and needle shaped riprap is unacceptable for use in riprap unless its thickness is greater than $\frac{1}{3}$ the length of the piece..
3. Riprap Weight:
 - a. Except for small stones and spalls used to chink interstices in the riprap, provide riprap stones weighing at least 10 pounds, but with the additional requirement that 50 percent or more of the riprap stone must weigh 100 pounds or more.
4. Riprap Size and Gradation:
 - a. Provide riprap stones as large as can conveniently be placed in a layer of the required depth.
 - b. Minimum Size: 1 inch.
 - c. Maximum Size: 1.5 times the d_{50} size.
 - d. Provide a well-graded mixture of stones for the riprap structures shown on the Contract Drawings.

F. Sacks:

1. Provide new or sound reclaimed burlap sacks weighing not less than 10 ounces.
2. Provide sacks having a capacity of 1.25 cubic feet, and sized approximately 19-1/2 inches by 36 inches when measured inside the seams when the sack is laid flat.

2.03 MIXES:

A. Portland Cement Mortar:

1. Provide Portland cement mortar consisting of 1 part Portland cement to 3 parts aggregate by volume.
 - a. Portland Cement:
 - 1) Provide low alkali Portland cement complying with the requirements for Type II low alkali Portland cement as specified in ASTM C 150.
 - 2) Unless otherwise approved by the Program/Project Manager, provide all cement of the same brand.
 - b. Aggregate:
 - 1) Provide aggregate consisting of 2 parts sand and 1 part gravel or blended gravel/crushed rock.
 - a) Sand:
 - (1) Provide fine granular material produced by crushing rock or gravel, or by the natural disintegration of rock, and washed to remove organic material, mica, loam, clay, oil, and other deleterious substances.
 - (2) Provide sand complying with the size and grading requirements of ASTM C 144.
 - (3) Provide sand having an average sand equivalent of 70 or greater from 3 successive test samples, with no individual



sample less than 65 when tested in accordance with the requirements of ASTM D 2419.

- b) Gravel:
 - (1) Provide gravel composed fully or partially of rounded or water worn particles capable of passing a 3/8 inch square mesh screen.
- c) Crushed Rock:
 - (1) Rock exceeding the gradation size requirements specified in ASTM D 448 and then crushed may be combined with the gravel, provided it is distributed and blended uniformly throughout the gravel.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 - a. Notify the Program/Project Manager when site samples of the materials intended for the Work of this Section are available for testing and inspection.
- 2. Testing:
 - a. The Testing and Inspection Agency or the City of Phoenix Testing Laboratory will perform the source testing specified in this Paragraph.
 - b. Resistance of Riprap Stones to Degradation Test:
 - 1) Test Procedure:
 - a) A prepared test sample of riprap stones will be tested in accordance with the requirements of ASTM C 131 for Grading A.
 - 2) Acceptance Criteria:
 - a) If the loss of the sample by abrasion is 10 percent or less by weight after 100 revolutions and 40 percent or less by weight after 500 revolutions, the riprap represented by the sample is acceptable.
 - c. Geotextile Filter Fabric Tests:
 - 1) Test Procedure:
 - a) Geotextile filter fabric will be tested for conformance to the property values specified in Table 02373-1 in accordance with the requirements of ASTM D 4759 and the requirements of the tests listed in the table.
 - 2) Acceptance Criteria:
 - a) Geotextile meeting the minimum requirements specified for the geotextile will be acceptable.

B. Non-Conforming Work:



1. Dispose of or otherwise prevent rejected stone at the quarry from mixing with satisfactory stone.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Examine the locations in dry areas where riprap is to be placed to verify that the area is clean and free of potholes, rills, voids, projections, debris, construction materials, and other foreign objects that could prevent the filter from being properly placed; and that the underlying soil is satisfactory because it does not have excessive in-place moisture content, is not frozen, and does not have roots, sod, turf clods, brush, or other similar organic materials.
 - a. Satisfactory surfaces include undisturbed native soil, excavated and prepared subgrade, and acceptably placed and compacted fill.
 - b. Unsatisfactory soils defined by the Program/Project Manager may include very fine, non-cohesive soils having uniform particle size; gap-graded soils; laminated soils; and dispersive clays.
2. Where riprap is to be placed in underwater areas, have scuba divers examine the bed to verify that it is free of logs, large rocks, construction materials, and other blocky materials that would create voids beneath the riprap system.

3.02 PREPARATION

A. Surface Preparation:

1. If required, clear and grub the area where the riprap will be installed in accordance with Section 02231, Clearing and Grubbing.
2. Excavate the trenches for the riprap where shown and as indicated on the Contract Drawings.
 - a. Excavate a footing trench along the toe of the slope of the riprap channel as shown on the Contract Drawings.
 - b. Excavate and grade the surfaces so the finished surfaces are uniform planes with no abrupt breaks in the surface.
 - 1) Shape and trim the bed for the riprap to provide even surfaces.
 - 2) Where riprap is to be placed in dry areas, grade the subgrade area to prepare a smooth surface that will ensure proper contact between the filter and the subgrade surface, and between the filter and the riprap.
 - a) Compact, shape, and uniformly grade the subgrade soil to the lines, grades, and cross-sections shown on the Contract Drawings.



- b) Compact, shape, and uniformly grade the termination trenches and transitions between slopes, embankment crests, benches, berms, and the toes of slopes.
- 3) If the riprap is to be placed underwater where flow velocities are greater than 1 foot per second, isolate the work area from water currents by diverting small streams around the work area during low flow seasons, or by constructing a temporary coffer dam on larger rivers or deep water areas and dewatering the work area.
 - a) Minimize environmental degradation during construction by implementing such measures as suspending a silt curtain made of plastic sheeting from buoys around the work area.
- c. If it is necessary to excavate beyond the normal lines of excavation or below subgrade to remove boulders or other interfering objects, backfill the voids with suitable material approved by the Program/Project Manager and in the same manner used to place other backfill in the vicinity of the void and to the same density.
 - 1) Remove unsatisfactory soils and backfill the voids created by the removal with approved material, then compact the approved backfill material prior to placing the riprap.
 - 2) Unless otherwise indicated, compact the backfill to a uniform density of 90 percent.
 - 3) If allowed by the Program/Project Manager, over-excavation may be filled with concrete or riprap.
- d. Finish the slopes on which sacked concrete will be placed to within 0.2 feet of the designated grade.

3.03 INSTALLATION OF FILTER MATERIAL:

- A. Install filter that is composed of one or more layers of granular filter material, of geotextile filter fabric, or a combination of geotextile filter fabric and a layer of granular filter material at the locations and to the grades and dimensions indicated on the Contract Drawings.
 - 1. Produce a continuous filter installation that maintains intimate contact with the soil beneath, and allows water infiltration and exfiltration to occur while insuring particle retention.
 - 2. Avoid voids, gaps, tears, and other holes in the filter material to the extent practicable.
 - 3. Geotextile Filter Fabric:
 - a. Place geotextile material on the prepared area, free of folds and wrinkles so that it is directly in contact with the subgrade.
 - b. Install the geotextile so that installation of the riprap will not excessively stretch or tear the geotextile.
 - c. Overlap upstream geotextile strips over downstream strips in the direction of flow.



- d. Overlap longitudinal and transverse geotextile joints, providing at least a 1.5-foot overlap for dry installations and at least a 3-foot overlap for underwater locations.
- e. Use anchoring pins, U-staples, or weights such as sandbags to maintain the recommended overlaps and expedite construction if necessary.
- f. If the geotextile is to be placed underwater, hold the geotextile in place using sandbags or sand-filled geocontainers made from non-woven, needle-punched geotextile fabric and placed so they overlap the required area.
- 4. Granular Filter Material:
 - a. Place granular filter material only in prepared areas having slopes flatter than 4:1, typically using front-end loaders to dump and spread the material.
 - b. Granular filter thickness depends on the size of the overlying riprap and whether a layer of bedding stone will be installed between the riprap and the filter.
 - 1) In dry installations, install granular filter 0.5 to 1.0 foot thick.
 - 2) In underwater installations, increase the normal dry thickness by 50 percent.

3.04 INSTALLATION OF PLAIN RIPRAP

- A. Placing Riprap Stones:
 - 1. For riprap less than 20 inches in depth, place riprap stones by hand.
 - 2. For riprap 20 inches or more in depth, riprap stones may be placed by hand or dumped and then spread by bulldozer or other suitable equipment.
 - 3. Place larger stones in the toe trench, foundation course, and on the outer surface of the riprap.
 - 4. Place stones to provide a minimum of voids.
 - 5. Chink the interstices between stones using small stones and spalls, but do not allow larger stones to bear on the smaller stones used to chink the voids.
 - 6. Place stones with their longitudinal axis normal to the face of the embankment, and so each stone above the foundation course has at least a 3 point bearing on underlying stones.
 - 7. Plain Riprap Finished Surface Tolerance:
 - a. Provide an even and tight surface not varying from the design surface by more than 3 inches per foot of depth.

3.05 INSTALLATION OF GROUTED RIPRAP

- A. Placing Riprap Stones:
 - 1. Place the riprap stones for grouted riprap in the same manner as for plain riprap.



- B. Mixing and Applying Portland Cement Mortar:
1. Deliver grout to the locations indicated on the Contract Drawings for grouted riprap by means approved by the Program/Project Manager.
 2. Except when the Program/Project Manager allows hand mixing, mix Portland cement mortar in an approved machine mixer for not less than 1-1/2 minutes.
 - a. If hand mixing is permitted, furnish a clean, tight mortar box for mixing the cement and aggregate; and thoroughly mix sufficient clean water with the other components to provide grout of the specified consistency and having a uniform color.
 3. Add water to the mix to provide grout of a consistency approved by the Program/Project Manager and that allows the grout to flow into interstices between the riprap stones with limited spading and brooming.
 4. Prior to placing grout, wet the surfaces of the riprap stone.
 5. Use the Portland cement mortar to grout the riprap stones where grouted riprap is indicated on the Contract Drawings.
 - a. After dumping each batch of grout, immediately distribute the grout over the surface using a method that will prevent segregation of the aggregate but works the grout so it penetrates into the voids between the riprap stones.
 - 1) Do not allow the grout to flow on the riprap surface more than 5 feet.
 - 2) To aid penetration of the grout into the voids, perform barring as necessary to loosen tight pockets of riprap.
 6. On sloped surfaces, successively place grout in 10-foot wide tiers beginning at the toe of slope and progressing toward the top of the slope.
 7. Remove grout from the top surfaces of the riprap using a stiff broom.
 8. Cure the grout by keeping the grout surface continuously wet for a minimum of 7 days, or by using some other means approved by the Program/Project Manager.

3.06 INSTALLATION OF SACKED CONCRETE RIPRAP

- A. Preparing the Sacks:
1. Loosely fill each sack with 1 cubic foot of concrete, leaving just enough room to allow the open end of the sack to be folded to retain the concrete when the filled sacks are placed.
 2. Place header sacks with their folds upward.
- B. Place the sacks in the trench as soon as they have been filled, and lightly trample them to conform their lower surface contours to the adjacent ground surface and the other sacks already placed.
1. Install a first course of sacks consisting of a double row of stretchers laid in the neatly trimmed trench.
 2. Lay a single row of headers as the second course.



3. For the third and remaining courses, lay stretchers or headers as shown on the Contract Drawings.
- C. Do not place more than 4 vertical courses in any tier until the initial set has occurred in the first course of that tier.
- D. Remove dirt and debris from the tops of previously placed sacks before laying the subsequent courses.
- E. Stagger the joints between courses.
- F. Cure the sacked concrete riprap by sprinkling a fine water spray on the riprap every 2 hours for at least 3 successive days.
- G. Special Techniques:
 1. If in the opinion of the Program/Project Manager delays in placing succeeding layers prohibit the proper bearing or bonding of the sacks, or if storms, mud, or other causes hamper the Work; excavate a small trench behind the row of sacks already in place and fill the trench with fresh concrete before placing more sacks.

3.07 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Density Test:
 - a. Test Procedure:
 - 1) The density of compacted fill materials will be determined in accordance with the Method A procedures specified in AASHTO T 99, and with AASHTO T 191 or ASTM D 2922 and ASTM D 3017.
 - 2) The density will be adjusted in accordance with the rock correction procedure for maximum density determination provided in MAG Standard Detail No. 190 to compensate for the rock content larger than that which will pass a No. 4 sieve.
 - b. Acceptance Criteria:
 - 1) Compacted fill materials having the specified compaction densities will be acceptable.
 2. Inspections:
 - a. Visually inspect the placing operations and the finished plain riprap surfaces to verify that a dense, rough surface of well-keyed graded rock of the specified quality and sizes is provided, that the layers are placed so that voids are minimized, and that the layers are of the thicknesses specified or shown on the Contract Drawings.
- B. Non-Conforming Work
 1. Correct deficiencies noted by inspections as soon as possible to prevent progressive failure of the system by successive flows.



3.08 PROTECTION

- A. After geotextile is installed, do not allow traffic over the area or other disturbances that might result in loss of contact between the riprap stone, the geotextile, and the subgrade.
 - 1. Do not allow geotextile to remain exposed longer than the geotextile manufacturer recommends in order to minimize potential damage from ultraviolet radiation from the sun.
- B. After sections of grouted riprap are completed, protect each section as follows:
 - 1. Prevent traffic by workers or equipment on the surface for 72 hours.
 - 2. Protect the surface of the grout from rain, flowing water, damage from the sun's rays, and mechanical injury.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First Edition



SECTION 02473

DRILLED CONCRETE SHAFTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing drilled concrete shafts constructed to the details and dimensions shown on the Contract Drawings at the locations indicated.
- B. Related Requirements:
 - 1. Section 01315 - Project Coordination.
 - 2. Section 01316 - Project Meetings.
 - 3. Section 01330 - Submittal Procedures.
 - 4. Section 01725 - Field Engineering.
 - 5. Section 01780 - Closeout Submittals.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Unit Prices:
 - 1. Base the bids on the number of drilled shafts indicated on the Contract Drawings, the design length from the top elevation to the bottom of the shaft, and the diameter of each shaft.
 - 2. The unit prices bid must include the labor, materials, tools, equipment, and incidentals required for the excavation, trimming, shoring, casings, dewatering, reinforcement, concrete, slurry, and other items required for a complete drilled shaft installation.
- B. Measurement and Payment Procedures:
 - 1. Drilled concrete shafts will be measured by the linear foot of each diameter as indicated on the Proposal Summary that is constructed, tested, and accepted as specified herein; and will be paid for at the accepted unit price on the Proposal Summary for the type of drilled concrete shaft indicated.
 - a. Payment will be made based on the net volume calculated using the shaft plan diameter of drilled shafts in place and accepted.
 - b. The actual length and shaft diameter may vary to coincide with the elevation where satisfactory bearing strata is encountered, and with the stability and characteristics of soil strata as determined by independent testing and inspection.
 - c. Adjustments to the Contract Price will be made based on the net variation of total quantities, compared to the design dimensions for the drilled concrete shafts.



2. Obstructions will be measured and paid for by each obstruction encountered.
3. The Contract price paid will be payment in full for furnishing all labor, materials, tools, equipment and incidentals, necessary to complete the work specified.
 - a. No additional payment will be allowed for the excavation, concrete fill, reinforcing, casings, or other costs due to unauthorized over-excavation of the shafts.
 - b. No additional payment will be allowed for temporary steel casing that remains in place.
 - c. No additional payment will be allowed for rejected drilled shafts.
 - d. No additional payment will be allowed for concrete required to fill an oversized temporary casing.
 - e. If the Testing and Inspection Agency and/or the code-required Approved Agency must perform additional materials testing due to changes in materials or proportions requested by the Contractor, or testing required by failure of material to meet specified requirements, the testing will be at no increase in the Contract Price.
4. Payment will be made under:

Bid Item	Description	Pay Unit
[]	Drilled Concrete Shafts – 48 Inch Diameter	Linear Foot
[]	Drilled Concrete Shafts – 72 Inch Diameter	Linear Foot
[]	Drilled Concrete Shafts – 84 Inch Diameter	Linear Foot
[]	Drilled Concrete Shafts – 96 Inch Diameter	Linear Foot
[]	Drilled Concrete Shafts – 108 Inch Diameter	Linear Foot
[]	Obstructions	Each

1.03 REFERENCES

A. Definitions:

1. Drilled Concrete Shafts: Foundation elements without enlarged bearing areas formed by drilling downward through earth materials to an acceptable design depth, with or without casings, and installing concrete reinforcing “cages” into the shaft and then filling the excavated hole with cast-in-place concrete.
2. Dry Construction Method: A method of constructing drilled concrete shafts consisting of drilling the shaft excavation to the desired size required on the Contract Drawings, using machine cleaning to remove accumulated water and loose material from the bottom of the excavation, placing the reinforcing cage, and concreting the shaft in a relatively dry excavation.
3. Dry Excavations: Drilled shafts having less than 3 inches of water in the bottom of the excavation.
4. Obstructions: Either material or objects of excessive dimension encountered which could not be reasonably inferred from the geotechnical



report; drilling tools lost in the excavation are not considered to be obstructions.

5. Wet Construction Method/Slurry Method: A method of constructing drilled concrete shafts within excavations containing water consisting of using water, polymer slurry, or mineral slurry to maintain the stability of the excavation perimeter while advancing the excavation to its final depth, placing the reinforcing cage, and concreting the shaft.

B. Reference Standards:

1. American Concrete Institute (ACI):
 - a. ACI 211.1-91 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - b. ACI 301-16 - Specifications for Structural Concrete.
 - c. ACI 305R-10 – Guide to Hot Weather Concreting.
2. American Society for Testing and Materials (ASTM):
 - a. ASTM A1064/A1064M-17 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - b. ASTM A615/A615M-16 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. ASTM A709/A709M-17 - Standard Specification for Structural Steel for Bridges.
 - d. ASTM C31/C31M-17 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - e. ASTM C33/C33M-16e1 - Standard Specification for Concrete Aggregates.
 - f. ASTM C39/C39M-17b - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - g. ASTM C94/C94M-17a - Standard Specification for Ready-Mixed Concrete.
 - h. ASTM C143/C143M-15a - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - i. ASTM C150/C150M-17 - Standard Specification for Portland Cement.
 - j. ASTM C172/C172M-17 - Standard Practice for Sampling Freshly Mixed Concrete.
 - k. ASTM C494/C494M-17 - Standard Specification for Chemical Admixtures for Concrete.
 - l. ASTM C1064/C1064-17 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
 - m. ASTM C1107/C1107M-17 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - n. ASTM D5982-15 - Standard Test Method for Determining Cement Content of Fresh Soil-Cement (Heat of Neutralization Method).
 - o. ASTM D6760-16 - Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing.



- p. ASTM E329-14a - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- 3. American Welding Society (AWS):
 - a. AWS D1.4/D1.4M:2011 – Structural Welding Code – Reinforcing Steel.
- 4. Arizona Department of Transportation (ADOT):
 - a. ADOT 2008 Standard Specifications for Road and Bridge Construction.
- 5. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications and Details for Public Works Construction.
- 8. U. S. Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 51 Requirements for Preparation, Adoption, and Submittal of Implementation Plans.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Attend the pre-installation meeting at the Site held in compliance with the requirements of Section 01316, Project Meetings, to discuss the requirements for constructing the drilled concrete shafts under this Contract.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Concrete reinforcement for the drilled concrete shafts per Subparagraph 2.02.B.1.
 - b. Special Procedure Submittals:
 - 1) Drilled Shaft Installation Plan per Subparagraph 1.06.A.1.a.
 - c. Delegated Design Submittals:



- 1) Design mixes on the "FINAL CONCRETE MIX DESIGN SUBMITTAL FORM".
 - a) Concrete.
- d. Qualification Statements:
 - 1) Drilled Shaft Subcontractor experience resume per Subparagraph 1.06.B.1.a.2.
 - 2) Certified copies of welder qualification test records per Subparagraph 1.06.B.2.a.1.
 - 3) Welding procedure qualification records per Subparagraph 1.06.B.2.b.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Source Quality Control Submittals:
 - 1) Concrete batch ticket information per Subparagraph 1.07.A.1.a.
 - 2) Laboratory test reports or field test data bases per Subparagraph 2.05.A.1.a.2.
 - b. Site Quality Control Submittals:
 - 1) Data for each drilled shaft.
 - 2) Test reports for slurry tests.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) Record Drawings documenting the actual location and construction of the drilled concrete shafts per Subparagraph 3.05.H.

1.06 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Drilled Shaft Installation Plan:
 - a. Not less than 30 calendar days prior to beginning construction of the drilled concrete shafts, prepare and submit a Drilled Shaft Installation Plan to the Program/Project Manager which includes the following information:
 - 1) The name and experience record of the Site supervisory personnel in charge of drilled shaft operations for this Contract.
 - 2) A List of Drilled Shaft Installation Equipment to be used for this work, including, but not limited to, drilling equipment, cranes, augers, bailing buckets, rock coring equipment, final cleaning equipment, de-sanding equipment, slurry pumps, tremie equipment, casings, concrete pumps, and similar items.



- 3) The construction operation sequence for the overall construction of the drilled shafts.
- 4) Detailed procedures for drilled shaft construction, including procedures for checking the dimensions and alignment of each shaft, temporary casing withdrawal (if applicable), and cleaning of drilled shaft excavation bottoms.
- 5) Reinforcement placement procedures, including support and centering methods in drilled shaft excavations.
- 6) Welding procedures for casing and reinforcement, and the AWS welder certifications.
- 7) Concrete placement procedures for free-fall, slurry, tremie, and pumping methods.
 - a) When slurry is required, provide details of the methods proposed to mix, circulate and de-sand the slurry, and slurry disposal methods.
 - b) In conformance with ACI 301, Chapter 4, provide the concrete supplier and concrete mix design(s) for the ready-mix concrete provided for each drilled shaft.
 - c) For slurry construction methods, provide test reports from the Supplier indicating the slurry type and admixtures and the physical and chemical properties of the proposed slurry to be utilized.
- 8) Other information requested on the Contract Drawings, or requested by the Program/Project Manager.
- b. The Program/Project Manager will evaluate the Drilled Shaft Installation Plan for conformance with the Contract Documents, and will within 14 calendar days after receipt of the Plan notify the Contractor of its approval or of additional information required and/or changes necessary to meet the Contract requirements.
 - 1) Parts of the Drilled Shaft Installation Plan that are unacceptable will be rejected, and the Contractor will be required to resubmit changes for re-evaluation.
 - 2) Procedural approvals given by the Program/Project Manager are subject to trial in the field and do not relieve the Contractor of the responsibility to satisfactorily complete the Work.
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.



3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory, and having the following additional qualifications:
 - 1) Qualified according to the requirements specified in ASTM C1107/C1107M.
 - 2) Capable of performing the reviews, inspections, and testing required by this Section; including but not limited to the following:
 - a) Inspecting, sampling, and testing proposed materials and concrete production as required by the Program/Project Manager for compliance with the Contract Documents.
 - (1) Capable of conducting concrete slump, strength, and air entrainment testing.
 - (2) Capable of securing production samples of materials at plants or stockpiles during the course of the Work, and testing the samples for compliance with the Contract Documents.
 - b) Capable of reviewing and testing the Contractor's proposed mix designs.
 - b. The Test and Inspection Agency performing Gamma-Gamma Logging (GGL) Integrity Testing must provide proof that it is licensed to possess and use radioactive material in accordance with the regulations of the Arizona Radiation Regulatory Agency.

B. Qualifications:

1. Drilled Shaft Subcontractor:
 - a. To construct the drilled concrete shafts, employ an experienced firm that has installed drilled shafts within similar soil conditions and with diameters and lengths similar to those shown on the Contract Drawings within the 3 years prior to the Bid date for this Contract.
 - 1) The Drilled Shaft Subcontractor's supervisor must have at least 3 years of acceptable experience installing similar types of drilled shafts.
 - 2) Demonstrate to the Program/Project Manager that the Drilled Shaft Subcontractor's supervisor and drillers proposed for performing the Work have completed at least 5 projects for drilled shaft diameters, lengths, and subsurface conditions similar in scope to this Contract, by submitting their experience resume.
2. Welding:
 - a. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.4/D1.4M for the procedures.



- 1) Submit certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures.
- b. Qualify welding procedures, and submit qualification records, as prescribed in AWS D1.4/D1.4M.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Measure, batch, mix, and deliver ready-mixed concrete according to ASTM C94/C94M.
 - a. Submit batch ticket information for each batch to the Program/Project Manager for information.
 2. Deliver concrete to the Site in an uninterrupted manner, and place it in the shaft excavation in a continuous manner so that all drilled shaft foundations are constructed without cold joints.
- B. Storage and Handling Requirements:
 1. Do not add water to the concrete mix in excess of the design mix amount.
 - a. Water may be added at the Site if the concrete was batched to less than the design water volume.
 - 1) The concrete truck must perform sufficient mixing revolutions if water is added at the Site prior to discharging the load.
 2. Maintain the concrete temperature so that it does not exceed 90 degrees Fahrenheit.

1.08 SITE CONDITIONS

- A. Ambient Conditions:
 1. Hot Weather Concreting:
 - a. Perform hot weather concrete work in accordance with the requirements of ACI 305R and the following additional requirements:
 - 1) Do not deliver concrete having a temperature exceeding 90 degrees Fahrenheit to the Work Site.
 - 2) Cool the mix's ingredients before mixing to prevent the temperature of the mix from exceeding 90 degrees Fahrenheit.
 - a) Furnish windbreaks, shading, fog spraying, sprinkling, or wet covering when necessary.
- B. Existing Conditions:
 1. Soil boring logs from subsurface investigations are available for information from the Program/Project Manager for information.
 - a. The data indicated on the available boring logs are not intended as representations or warranties of continuity of such conditions.



PART 2 PRODUCTS

2.01 PERFORMANCE

- A. Perform the excavations required for drilled concrete shafts through whatever materials are encountered to the dimensions and elevations shown on the Contract Drawings or otherwise required by the Specifications.
 - 1. Employ methods suitable for the intended purpose and materials encountered.
 - 2. Employ the dry construction method only at sites where the groundwater level and the soil conditions are suitable to permit construction of the shaft in a relatively dry excavation, and where the Program/Project Manager can verify the dryness of the excavation bottom by viewing the auger cuttings, auger, bell bucket, one-eye bucket, and/or by using a weighted tape prior to placement of concrete.
 - a. The Program/Project Manager will determine the final bearing level.
 - 3. Employ the wet construction method or slurry construction method at sites where a dry shaft excavation bottom cannot be maintained for placement of the drilled shaft concrete.
 - 4. Comply with the safety requirements of 29 CFR 1910 and 29 CFR 1926.

2.02 DESIGN CRITERIA

- A. Capacities:
 - 1. The drilled concrete shafts for this Contract have been designed for an allowable vertical axial capacity (dead load plus live load) as indicated in the Geotechnical Design Memorandum using skin friction and end-bearing.
- B. Shop Drawings:
 - 1. Prepare and submit Shop Drawings that detail the fabrication, bending, and placing of the concrete reinforcement for the drilled concrete shafts.

2.03 MATERIALS:

- A. Concrete:
 - 1. Provide the following materials to produce the concrete mix designs required by this Section.
 - 2. Portland Cement:
 - a. Provide Portland cement complying with the requirements for Type II as specified in ASTM C150.
 - 1) Where concrete is to be placed in drilled shaft excavations containing mineral slurry, polymer slurry, or water, provide concrete having a cement content of between 660 and 750 pounds per cubic yard.
 - 3. Aggregate:



- a. Provide aggregate complying with the requirements for uniformly graded aggregate specified in ASTM C33.
 - 1) Limit the maximum aggregate size to 20 percent of the minimum clear bar spacing (vertical and horizontal); but not exceeding 1 inch for drilled shafts constructed using a dry method of concrete placement and $\frac{3}{4}$ inch for drilled shafts constructed using a wet method of concrete placement.
 4. Water:
 - a. Provide potable water complying with the requirements specified in ASTM C94/C94M.
 5. Admixtures:
 - a. Provide admixtures certified by the manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of the cementitious material, and to be compatible with the other admixtures and cementitious materials.
 - b. Do not use admixtures containing calcium chloride.
 - B. Concrete Reinforcement:
 1. Reinforcing Bars:
 - a. Provide deformed steel reinforcing bars complying with the requirements for Grade 60 as specified in ASTM A615/A615M.
 - C. Controlled Low Strength Material (CLSM):
 1. Provide controlled low strength material (CLSM) consisting of cement-enriched aggregate base course slurry having the cement content listed in Table 02473-1:
- | CLSM Type | Cement Content⁽¹⁾ (lbs/yd³) |
|---|--|
| 1 Sack | 94 ± 5 percent |
| 1-1/2 Sack | 141 ± 5 percent |
| 3 Sack | 282 ± 5 percent |
| 1. Determine cement content in accordance with the requirements specified in ASTM D 5982. | |
2. Submit a mix design for the controlled low strength material (CLSM) to the Program/Project Manager for approval prior to placing the controlled low strength material.
 - D. Temporary and Permanent Casing:
 1. Provide casing fabricated from steel complying with the requirements for Grade 36 as specified in ASTM A709/A709M, unless indicated otherwise.



2. Provide watertight casing of sufficient strength to withstand handling stresses, drilling stresses, concrete fluid pressures, surrounding earth and water pressures, and if required, to permit advancement of shaft excavation through caving ground.
3. Provide casing outside diameters not less than the specified diameter of the drilled concrete shaft.
4. Only use permanent casing when authorized by the Program/Project Manager.

2.04 MIXES

- A. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases.
 1. Prior to producing concrete or controlled low strength material (CLSM), submit all mix designs proposed for the Contract to the Program/Project Manager for approval on the form appended to the end of this Section.
 - a. Include a standard deviation analysis or laboratory trial mixture test data with the submittal in accordance with Section 4 of ACI 301.
 - b. Use the materials specified in this Section in the proposed design mixes.
 - c. Make adjustments in the proposed design mix as directed by the Program/Project Manager.
- B. Proportion concrete mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
 1. Compressive Strength (28 days), f'_c : 4000 psi minimum, or as noted on the Contract Drawings.
 - a. Provide tremie concrete having a minimum f'_c as noted on the Contract Drawings.
 2. Minimum Slump: As indicated in Table 02473-2.

Table 02473-2 Concrete Slump	
Slump Range	Condition
5 – 7 inches	Dry uncased shaft excavation
6 – 8 inches	Temporary casing
7 – 9 inches	Concrete placed by wet or slurry displacement methods

- C. The concrete mix may not contain water-soluble, chloride ion admixtures.



- D. If the characteristics of the materials, Contract conditions, weather, test results, or other circumstances warrant, adjustments to the concrete mix design may be considered.

2.05 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Laboratory Trial Mix Tests, or field test data bases:
 - a. Test Procedure:
 - 1) Use a qualified testing agency for preparing and reporting the proposed mix designs for the laboratory trial mix basis.
 - 2) Submit the laboratory test reports or field test data bases to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Mixes that meet the specified requirements will be acceptable.
- B. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing Special Inspections when concrete for this Contract requiring Special Inspections as noted on the Contract Drawings is being mixed, placed, and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Prior to commencement of drilled shaft construction, examine the site to determine if there are any constraints to the Work presented by the existing surface conditions, and if any, report them to the Program/Project Manager.
 - 2. Review the available soil boring logs from the subsurface investigation(s).
 - a. If during construction, it is determined that the actual subsurface conditions differ substantially from those reported on the boring logs, notify the Program/Project Manager in writing within 48 hours of such determination.
 - 3. Before beginning to excavate drilled shafts, locate existing underground utilities as specified in Section 01315, Project Coordination.
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona 811 at (602) 659-7500 to arrange for utility owners to locate and mark their underground utilities.



- 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
- B. Pre-Installation Testing:
1. Additional soil test borings and other exploratory procedures may be performed by the Contractor if at no increase in the Contract Price.
- C. Evaluation and Assessment:
1. It is expressly understood that the City of Phoenix and the Program/Project Manager will not be responsible for interpretations or conclusions drawn from the soil boring logs by the Contractor.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. If existing utilities are to remain in place, protect them from damage during drilled shaft operations.
 2. Control drilled concrete shaft installation operations to prevent damage to existing structures and utilities.
 - a. Preventative measures include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, and monitoring and controlling the vibrations from construction activities, such as installation of casing and drilling of the shaft.
 - b. During all drilled shaft excavating and concreting operations, monitor existing structural elements within 10 drilled shaft diameters or a minimum of 50 feet away from drilled shafts measured center-to-center in accordance with the "Monitoring Notes Related to the Existing Structures" on the Contract Drawings.
- B. Surface Preparation:
1. Before beginning to excavate, have the Surveyor, required by Section 01725, Field Engineering, lay out each drilled shaft to the lines and levels required.
 - a. Record and maintain information pertinent to each drilled shaft, and cooperate with the Approved Agency performing special testing and inspections to provide data for required reports.
 - 1) Record the actual measurements of each drilled shaft's location, shaft diameter, bottom and top elevations, deviations from specified tolerances and other specified data.



3.03 DRILLING THE EXCAVATION

- A. Provide excavation and drilling equipment that has adequate capacity, including power torque and down-thrust, to excavate a shaft of both the maximum diameter and depth indicated on the Contract Drawings.
- B. Raising the tip elevation of the drilled shaft requires approval by the Program/Project Manager.
- C. If satisfactory bearing material is not encountered at the elevation indicated on the Contract Drawings, at the direction of the Program/Project Manager the bottom of any drilled shaft may be lowered.
- D. If caving soil conditions are encountered, employ a construction method acceptable to the Program/Project Manager which will prevent excessive caving.
- E. If the wet construction or slurry construction methods are used, then desanding and cleaning the slurry; final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump, or other approved devices; and placing the shaft concrete beginning at the shaft bottom using a tremie or concrete pump may be required.
 - 1. During construction, maintain the slurry in the shaft excavation at a level not less than the highest expected groundwater level within the depth of the shaft.
 - 2. If the slurry method is used, make the slurry suspension using a sufficient percentage of material and with a specific gravity capable of maintaining the stability of the excavation and allowing proper concrete placement.
 - a. Only employ commercially prepared mineral slurries or polymer slurries.
 - b. Premix the mineral slurry or polymer slurry thoroughly with clean, fresh water.
 - 1) Furnish slurry tanks for slurry circulation, storage, and treatment.
 - 2) Do not mix the slurry within the drilled shaft excavation, except in cases where the slurry manufacturer allows it, and the Program/Project Manager approves of it.
 - 3) Excavated slurry pits are not allowed.
 - c. Prior to introducing the slurry into the shaft excavation, allow adequate time for hydration to occur as prescribed by the manufacturer.
 - d. Use whatever methods are necessary to prevent the slurry from setting up in the shaft.
 - 1) Methods may include, but are not limited to, agitation, circulation and/or adjusting the properties of the slurry.
 - 2) During work shifts, do not allow the slurry to stand for more than 4 hours in the excavation without agitation.



- 3) If concrete placement does not occur by the end of a work shift, or if an existing excavation contains slurry at the beginning of a work shift, agitate/circulate the slurry in the excavation.
 3. Use controlled low strength material (CLSM) only after its use is approved by the Program/Project Manager, and only within the depth intervals approved by the Program/Project Manager.
- F. Cover all open excavations at the end of each day in a manner approved by the Program/Project Manager and the City of Phoenix.

3.04 INSTALLING CASING AND CONCRETE REINFORCING STEEL

- A. Do not place reinforcing steel and concrete in the drilled shaft excavation until the design tip elevation has been reached and the excavation is acceptable to the Program/Project Manager.
- B. Prior to placing temporary casing in the excavation, clean the casing inside and out.
 1. If temporary casing is abandoned in the shaft excavation, the Contractor is responsible for the loss of frictional capacity in the cased zone.
 - a. If installed temporary casing becomes permanent, no side friction capacity will be allowed.
 - b. Such modifications are allowed only if no increase in the Contract Price results.
 - c. Notify Program/Project Manager immediately for direction on making adjustments to drilled shaft lengths per design requirements.
- C. Before placing reinforcing steel and dowels, clean off loose rust, scale, dirt, grease, and other materials which could reduce or destroy the bond to the concrete.
- D. Where a reinforcing cage consisting of longitudinal bars and spiral reinforcement or lateral ties is indicated on the Contract Drawings, completely assemble the cage prior to placing it in the shaft excavation.
 1. Provide Grade 60 reinforcing steel bars that comply with the requirements of ASTM A615/A615M.
- E. Place the reinforcement in accordance with the details shown on the Contract Drawings
 1. Do not place the steel reinforcing cage in the drilled shaft excavation until immediately before concrete operations are to be started.
 - a. In the areas at airport terminals where time constraints prohibit placement of concrete immediately following placement of the steel reinforcing cage, the reinforcing cage can be placed in the drilled shaft excavation up to 24 hours before placing concrete.



2. Splice vertical reinforcement steel only as indicated on the Contract Drawings, or as approved by the Program/Project Manager.
- F. Hold reinforcement securely in position during concrete placement.
 1. Provide spacers on the exterior of the reinforcing cage at sufficient intervals to ensure concentric spacing of the cage for its entire length within the shaft excavation.
- G. Furnish and install dowels in the top of drilled shafts where concrete components will be constructed above.
 1. Extend the dowels for a lap of 24 bar diameters, unless noted otherwise on the Contract Drawings.

3.05 PLACING CONCRETE

- A. Place drilled shaft concrete the same day the shaft excavation is completed in accordance with Section 601, Concrete Structures, of the ADOT Standard Specifications for Road and Bridge Construction.
 1. In the areas at airport terminals where time constraints prohibit placement of concrete immediately following placement of the steel reinforcing cage, the concrete can be placed in the drilled shaft excavation up to 24 hours after placing the steel cage, provided the actual shaft bottom elevation is equal to or greater than the design drilled shaft tip elevation.
- B. For concrete placement in dry excavations, concrete may be placed using free-fall methods provided the concrete is not allowed to contact the earth walls of the drilled shaft excavation, the temporary casing, or the steel reinforcement.
 1. A drop chute, elephant trunk hopper or equivalent may be used for this purpose.
- C. Exercise due care to prevent upward movement of the shaft concrete and/or reinforcing steel while extracting the temporary casing.
 1. Take corrective action when the upward movement exceeds one inch.
 - a. Corrective action may include leaving the casing in place and compensating for the loss of frictional capacity in the cased zone.
- D. Vibrate the upper 10 feet of concrete placed in dry excavations following removal of any temporary casing.
 1. Stop concrete placement at the cut-off elevation shown on the Contract Drawings, and screed the concrete level.
- E. When withdrawing the casing from the excavation, maintain a head of concrete at least 5 feet above the bottom of the temporary casing to prevent a reduction in shaft diameter due to earth or hydrostatic pressures on the fresh concrete, and to prevent extraneous materials from falling in from the sides and mixing with concrete.



1. Compare the actual volume of concrete used against the theoretically calculated volume to detect large voids or intrusions of foreign matter.
- F. Before withdrawing the casing from the excavation, ensure that the level of concrete in the shaft is sufficiently high to remain above the water level elevation in the shaft excavation as the concrete level drops to fill the void created by removal of the casing.
- G. Placing Concrete Using Wet or Slurry Methods:
 1. For placing concrete using wet or slurry methods, furnish tremie pipes and pump pipes made of steel; do not use aluminum.
 2. Furnish a tremie pipe having an inside diameter of at least 8 inches, and a pump pipe having an inside diameter of at least 5 inches.
 3. Place the discharge end within 12 inches of the bottom of the excavation prior to commencement of concrete placement.
 4. Provide the lower end of the pump or tremie pipe with a valve, sealable cap, or plug ("pig").
 - a. If a plug is used, insert it at the top after the pipe has been set in place.
 5. Do not lift the open end of the tremie pipe until the tremie pipe is completely filled with concrete.
 6. Maintain a head of 5 feet or more of concrete in the tremie pipe above the level of concrete in the drilled shaft except at the top of the shaft. During removal of temporary casing, maintain a head in the tremie pipe of at least 10 feet above the level of concrete in the drilled shaft, except at the upper 10 feet of the shaft.
 - a. Remove contaminated concrete from the shaft.
 7. Vibrate the upper 5 feet of concrete placed in wet excavations following removal of any temporary casing and after the slurry or water and any contaminated concrete has been totally expelled from the shaft.
- H. Record Drawings:
 1. At project closeout, submit record drawings documenting the actual location and construction of the drilled concrete shafts prepared using information obtained during the course of the Work.

3.06 TOLERANCES:

- A. The outside diameter of the drilled shaft cannot exceed the dimension on the Contract Drawings by more than 6 inches unless the use of telescoping casing or shallow surface casing is allowed by the installation plan.
- B. Horizontal Alignment:
 1. The actual centerlines of the drilled shaft must be within 5 percent of the shaft diameter at the plan elevation for the top of the shaft, not to exceed 3 inches of plan centerlines.



- C. Plumb:
 - 1. The out-of-plumbness at the drilled shaft actual bottom elevation must not be greater than 1-1/2 percent of the drilled shaft length.
- D. Reinforcing Steel:
 - 1. After all the shaft concrete is placed, the top of the reinforcing steel cage must not be more than 6 inches above, and no more than 3 inches below, the plan position.
 - 2. The reinforcing cage shall be concentric with the drilled shaft excavation within a tolerance of 1-½ inches.
- E. Top of Shaft Elevation:
 - 1. The top elevation of the shaft shall have a tolerance of plus 1 inch to minus 3 inches from the plan top of shaft elevation.
- F. Bottom of Excavation:
 - 1. Design excavation equipment and methods so that the completed shaft excavation bottom will consist of a level plane within a tolerance of 1 vertical to 12 horizontal.
 - 2. The cutting edges of excavation equipment must be normal to the vertical axis of the equipment within a tolerance of plus or minus 0.35 inch per foot of diameter.
 - 3. The bottom of the excavation must be clean of excavation cuttings, caved-in materials, and materials settled out of suspension at the time of placement of the concrete to the satisfaction of the code-required Approved Agency and the Program/Project Manager.

3.07 RESTORATION

- A. For drilled concrete shafts where casings are not used, fill the excavation space extending beyond the dimensions shown on the Contract Drawings with concrete at no increase in the Contract Price.

3.08 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. The Program/Project Manager and the code-required Approved Agency must perform routine and other testing of materials in addition to testing performed by the Contractor.
 - a. Advise the Program/Project Manager and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) The Program/Project Manager and code-required Approved Agency will provide test reports documenting the testing they perform to the Contractor for information.



- b. A drilled shaft report will be prepared by the code-required Approved Agency for each drilled shaft, and include the following information:
 - 1) Actual top and bottom drilled shaft elevations.
 - 2) Actual diameter of drilled shaft.
 - 3) Description of soil materials encountered during drilling.
 - 4) Description, location, and dimensions of obstructions.
 - 5) Top of shaft centerline location, and deviations from requirements.
 - 6) Variation of shaft from plumb.
 - 7) Adequacy of cleanout of bottom of shaft.
 - 8) Groundwater conditions and water infiltration rate, depth, and pumping.
 - 9) Description of excavation sidewall stability, loss of ground, and means of control.
 - 10) Length and diameter of temporary casing.
 - 11) Theoretical and actual volume of concrete placed in cubic yards.
 - 12) Date and time of start and completion of excavation and concrete placement, including any delays during concrete placement.
 - 13) Reinforcing steel data.
 - 14) Concrete placement method.
 - 15) Remarks, unusual conditions encountered, and deviations from requirements.
 - c. Failure of the Program/Project Manager or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Site Tests:
- a. Slurry Property Tests:
 - 1) Test Procedure:
 - a) Perform the slurry property tests to ensure that the slurry suspension will not impede the flow of concrete to the bottom of the drilled shaft excavation.
 - b) Supply all equipment needed to allow sampling the slurry at any depth within the drilled shaft excavation.
 - c) Extract and test slurry samples from the base of the shaft and at the midpoint of the shaft until samples produce acceptable values for density, viscosity or yield point, pH, and sand content.
 - (1) A minimum of 4 sets of tests will be performed during the first 8 hours of slurry use to determine the slurry's density, yield point or viscosity, pH, and sand content using the methods specified in Paragraph 3.04 of Section 609 in the ADOT Standard Specifications for Road and Bridge Construction.



- (2) Once the test results show consistent behavior, the testing frequency may be decreased to 1 set for every 4 hours of slurry use.
 - (3) If any slurry samples are found to be unacceptable, take whatever means are necessary to bring the slurry to within the specified requirements.
 - (4) Do not place drilled shaft concrete until re-sampling and retesting results produce acceptable values.
 - d) Upon completion of each drilled shaft where slurry installation methods are used, prepare test reports for the slurry tests performed, and submit copies of the test reports to the Program/Project Manager for information.
- 2) Acceptance Criteria:
- a) For mineral slurries, a range of acceptable values for the slurry physical properties can be found in Table 02473-3.

Table 02473-3 Acceptable Values of Physical Properties for Mineral Slurries		
Physical Property	Acceptable Values	<u>Test Method</u>
Density (Pounds per Cubic Foot)		
During drilling	64.3 – 69.1	Density Balance
Immediately prior to placing concrete	64.3 – 75.0 (85 with Barite agents)	Density Balance
Viscosity (Seconds per Quart)		
During drilling	28 to 50	Marsh Funnel
Immediately prior to placing concrete	28 to 50	Marsh Funnel
pH	7 to 12	pH Paper or pH meter
Sand Content (Percent)		
At introduction	0 to 4	API Sand Content Kit
Immediately prior to placing concrete	0 to 2	API Sand Content Kit



- b) For polymer slurries, the ranges of acceptable values for physical properties can be found in Table 02473-4.

Table 02473-4 Acceptable Values of Physical Properties for Polymer Slurries	
Physical Property	Acceptable Values
Density (Pounds per Cubic Foot)	
During drilling	≤ 64
Immediately prior to placing concrete	≤ 64
Viscosity (Seconds per Quart)	
During drilling	32 to 135
Immediately prior to placing concrete	32 to 135
pH	8 to 11.5
Sand Content (Percent)	
At introduction	< 1
Immediately prior to placing concrete	< 1

b. Concrete Tests:

1) Test Procedure:

- a) The Program/Project Manager's Testing and Inspection Agency will sample fresh concrete in accordance with the requirements of ASTM C172, except as modified for slump to comply with these specifications.
- b) The concrete compressive strength will be determined in accordance with the requirements of ASTM C31/C31M.
 - (1) Obtain one set of 4 standard cylinders for each compressive strength test unless otherwise indicated.
 - (a) Mold and store the cylinders for laboratory-cured test specimens, unless field-cured test specimens are required.
 - (2) The concrete compressive strength tests will be performed in accordance with the requirements of ASTM C39/C39M.
 - (a) One set of concrete compressive strength tests will be performed for each drilled shaft, but not more than one set for each truck load.



- (b) Retain one cylinder from each set in reserve for later testing if it is required.
 - (c) When the frequency of testing will provide fewer than 5 strength tests for a given class of concrete, testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used will be conducted.
 - c) The concrete slump will be determined in accordance with the requirements of ASTM C143/C143M.
 - (1) One test will be performed at the point of placement for each compressive strength test, but no fewer than one test for each drilled shaft.
 - d) The concrete temperature will be determined in accordance with the requirements of ASTM C1064.
 - (1) One test hourly will be performed when the air temperature is 40 degrees Fahrenheit and below, and when 80 degrees Fahrenheit and above, and one test will be performed for each set of compressive strength specimens.
 - e) The Program/Project Manager's Testing and Inspection Agency will report the test results in writing to the concrete Supplier, the Program/Project Manager, and the Contractor within 24 hours of the testing.
 - (1) With the reports of the compressive strength tests the project identification name and number, the date of concrete placement, the name of the concrete testing and inspection agency, the concrete type and class, the location of the concrete batch in the drilled shaft, the design compressive strength at 28 days, the concrete mix proportions and materials, and the compressive strength and type of break for both 7- and 28-day tests will be included.
- 2) Acceptance Criteria:
 - a) The strength level of the concrete will be considered satisfactory if the averages of sets of 3 consecutive strength test results equal or exceed the specified compressive strength, and no individual strength test result falls below the specified compressive strength by more than 500 psi.
- c. Integrity Testing:
 - 1) Test Procedure:
 - a) The Program/Project Manager's Testing and Inspection Agency will perform integrity tests on all drilled shafts constructed under this Contract.
 - (1) Integrity testing will include performing both Gamma-Gamma Logging (GGL) and Cross-Hole Sonic Logging (CSL).



- b) Either at the discretion of the Program/Project Manager or based on the results of the Gamma-Gamma Logging (GGL) and/or Cross-Hole Sonic Logging (CSL), additional testing such as offset elevation cross-hole sonic logging, three-dimensional tomography, sonic echo tests or coring may be required.
- c) Integrity testing will generally be performed in accordance with the requirements specified in Subsection 609-3.05, Integrity Testing, in the ADOT Standard Specifications for Road and Bridge Construction.
- d) Integrity Testing Access Tubes:
 - (1) Provide the number of clean, watertight, and unobstructed 2-1/2-inch diameter Schedule 80 PVC pipes required for the integrity tests as indicated on the Contract Drawings, but not less than 4, uniformly distributed along the inside circumference of the reinforcing steel cage.
 - (a) Provide 1 access tube for each foot of shaft diameter, rounded up to the next integer for diameters not in whole foot increments.
 - (b) Fit the tubes with a watertight cap at the bottom and a removable watertight cap or plug at the top to prevent concrete and debris from entering the tubes.
 - (c) Extend the tubes vertically from not more than 6 inches above the bottom of the reinforcing cage to at least 4 feet above the top of the shaft, or to 2 feet above the top of the rebar cage if it is above the ground.
 - (d) If joints are needed to provide the full tube length required, make the joints watertight.
 - (e) Securely fasten the tubes to the reinforcing cage at least every 10 feet vertically, and parallel to each other.
 - (f) Do not allow the tubes to rest on the bottom of the drilled shaft excavation.
 - (g) If the top of the drilled shaft is subsurface, extend the tubes to allow safe and ready access from ground level.
 - (h) Prevent damage to the tubes, tube couplings, and caps during installation of concrete reinforcement.
 - (2) Completely fill the tubes with water immediately prior to or immediately after placement of the concrete in the drilled concrete shaft, but not more than 1 hour after concrete placement is completed.
 - (a) Do not allow the water level to drop below the top of the tube prior to performing the integrity tests.



- (3) Prior to the performance of the integrity testing, a 1.5 inch diameter, 6-foot long rigid cylinder will be run through the entire length of each access tube to check the tubes for blockages.
 - (a) If blockages in the tubes prevent performing the test, core-drill or otherwise determine the extent of the defects in the concrete as directed by the Program/Project Manager at no increase in the Contract Price.
 - (4) Prior to the performance of the integrity testing, submit the following data for each drilled shaft to the Program/Project Manager for information:
 - (a) The top and bottom elevations of the shaft.
 - (b) The tube positions and lengths.
 - (c) The date the shaft was constructed.
 - (5) The Integrity Testing will not be performed until at least 48 hours after placement of the concrete.
 - (6) Cross-Hole Sonic Logging (CSL) will be completed within 4 calendar days of concrete placement.
 - (7) Gamma-Gamma Logging (GGL) will be completed within 7 calendar days of concrete placement.
- 2) Cross-Hole Sonic Logging (CSL) Integrity Test:
- a) Test Procedure:
 - (1) Readings from the cross-hole sonic logging will be taken at maximum intervals of 2 inches from top to bottom of the uniquely identified tubes in a manner similar to the procedures specified in ASTM D6760 and ADOT Specifications, and will include all possible ultrasonic "ray" paths.
 - (a) All possible tube pairs will be tested.
 - (b) Unless test results indicate potential defects, the source and receiver probes will be in the same horizontal planes when readings are taken.
 - (c) The minimum pulse frequency will be 40,000 Hz.
 - (2) The test results, including the acquired raw data, graphs of acoustic pulse arrival time versus depth, and power of the arriving signal versus depth, in each pair of tubes provided will be recorded.
 - (3) After the test has been completed and if the drilled shaft has been approved, fill the holes and test pipes from the bottom up with an approved grout having a minimum 28-day compressive strength of 1000 psi.
 - b) Acceptance Criteria:
 - (1) If the Cross-Hole Sonic Logging indicates velocity reductions less than 10 percent of the mean measured



- velocity in the drilled shaft foundation, then the drilled shaft passes the Cross-Hole Sonic Logging (CSL) test.
- (2) If the Cross-Hole Sonic Logging indicates velocity reductions greater than 10 percent of the mean measured velocity in the drilled concrete shaft foundation, or if the Program/Project Manager determines that construction defects may have occurred, then the drilled shaft is considered to have failed the test.
- 3) Gamma-Gamma Density Logging (GDL) Integrity Test:
- a) Test Procedure:
- (1) A gamma-gamma probe, consisting of a rigid cylinder containing a gamma particle emitting source and a gamma particle detector, will be suspended by a cable capable of raising and lowering the probe to the desired test depths within an inspection tube.
- (a) The gamma particle emitting source will be Cesium-137 in a sealed source form.
- (b) The gamma particle detector will consist of a gamma ray detector, such as a Geiger Mueller or scintillation-based counter, connected to a readout device capable of displaying and/or recording counts, densities, and sampling duration or probe speed.
- (2) The gamma-gamma logging will be performed in access tubes completely filled with water only if the gamma-gamma probe has been calibrated in concrete calibration samples that contained access tubes filled with water, and the radius of detection and density precision calibration have been performed under water and found to be within prescribed limits.
- (a) If gamma-gamma logging is performed in water-filled tubes, the water level in any tube during testing is not allowed to drop below the top of the tube.
- (3) Readings from the gamma-gamma logging will be taken at maximum intervals of 1.5 inches and within a density precision of 1.0 pound per cubic foot as the probe is raised from the bottom to the top of the uniquely identified tubes in a manner consistent to the procedure specified in ADOT Special Provision 609DRSFD.
- (4) One repeat log will be performed for each shaft tested to evaluate the repeatability of the GGL tests.
- (a) After all of the tubes in a given drilled shaft have been tested by Gamma-Gamma Logging (GGL), the repeat log will be performed in the first tube that was tested.
- (5) The test results will be recorded as the probe is extracted at a rate of between 8 to 10 feet per minute.



- (a) A calculation using the raw data will be performed.
- (6) In the event a known difference in the steel reinforcement, such as splices using overlapping bars, exists in a segment of a drilled shaft which affects the apparent mean of the data, then a separate mean will be generated and used as the mean for that portion of the data.
- (7) The following data will not be included in the calculation of the mean density:
 - (a) Repetitive data points collected at a single depth.
 - (b) Data collected at the top of the drilled shaft where the reading(s) were influenced by the gamma detector component exiting the drilled shaft.
 - (c) Data collected in the access tube above the top of the drilled shaft.
 - (d) Data affected by the anomalous zones of concrete.
 - (e) Data which cause the population distribution to be statistically non-normal.
- (8) In the analysis of the data, the Standard Deviation value between 2.5 pounds per cubic foot and 3.75 pounds per cubic foot will be used.
 - (a) If the calculated value is below 2.5 pounds per cubic foot, then a value of 2.5 pounds per cubic foot will be used.
 - (b) If the calculated value is above 3.75 pounds per cubic foot, then a value of 3.75 pounds per cubic foot will be used.
- (9) After the test has been completed and if the drilled shaft has been approved, fill the holes and test pipes from the bottom up with an approved grout having a minimum 28-day compressive strength of 1000 psi.
- b) Acceptance Criteria:
 - (1) If in all inspection tubes for a drilled shaft the Gamma-Gamma Logging (GGL) indicates no anomalies as defined in Subparagraphs 3.08.A.2.c.3.b.2 below, then the drilled shaft passes the Gamma-Gamma Logging (GGL) Integrity Test.
 - (2) If in a single inspection tube, all density readings over a 0.5-foot or greater depth interval are less than the mean density value by 3 standard deviations, that area is considered to be an anomaly.
 - (a) If, in addition to the anomaly identified in Subparagraph 3.08.A.2.c.3.b.2, some data point for the tube falls below the 3-standard deviation value within 1 foot above or below the anomaly, that depth will also be considered anomalous.



- (b) If in the inspection tubes adjacent to the identified anomaly some data point 2 feet above or below the identified anomaly in the other tube falls below the 3 standard deviations value, then the depth in that tube at which the anomaly is found is also anomalous.
 - 4) If the integrity testing indicates the presence of anomalies, offset elevation cross-hole sonic logging, three-dimensional tomography, sonic echo tests and/or other tests may be conducted as directed by the Program/Project Manager to determine if the drilled shaft is defective.
 - a) Any such additional testing shall be considered as included in the contract price for drilled shafts.
 - b) Nondestructive testing will not be used as the sole basis for acceptance or rejection of the concrete.
 - c) Final acceptance of the drilled shafts will be determined by the Program/Project Manager.
 - d) Do not commence subsequent construction of structures supported by the drilled concrete shafts until the Program/Project Manager approves the supporting drilled shaft.
- d. Additional Tests:
 - 1) Test Procedure:
 - a) When test results indicate concrete strengths or other requirements have not been met, the Program/Project Manager may direct the performance of additional tests on the concrete. Any such additional testing shall be considered as included in the contract price for drilled shafts.
 - b) Continuous coring of the drilled shafts may be required, at no increase in the Contract Price where observations of placement operations indicate deficient concrete quality, the presence of voids, segregation, or other possible defects. Coring shall be performed using double-tube or triple-tube core barrels.
 - 2) Acceptance Criteria:
 - a) As specified for the type of test.
- 3. Inspections:
 - a. Construction Method Log.
 - 1) During the excavation and construction of the drilled shafts, maintain and submit to the Program/Project Manager a Daily Construction Method Log which contains the following information for each drilled shaft:
 - a) Start date and completion date for the drilled concrete shaft.
 - b) Identification number of the drilled concrete shaft.
 - c) Location of the drilled concrete shaft.
 - d) Actual top and bottom elevation of drilled shaft.



- e) Shaft diameter.
 - f) Final centerline location at top.
 - g) Variation of the drilled concrete shaft from plumb.
 - h) Description of each soil and rock material encountered during excavation, and their approximate top and bottom depths or elevations.
 - i) Depth drilled into bearing stratum.
 - j) Top and bottom elevations of obstructions encountered.
 - k) Depth or elevation of encountered seepage or groundwater.
 - l) Quantity of concrete placed.
 - m) Remarks.
- B. Non-Conforming Work
- 1. If drilled concrete shafts are determined to be defective, submit a plan to the Program/Project Manager for repairing, replacing, or supplementing the defective work for approval.
 - a. Perform the approved repairs at no increase in the Contract Price.
 - 2. Drilled shaft excavations and completed shafts not constructed within the required tolerances will be considered unacceptable.
 - a. Correct all unacceptable shaft excavations and completed shafts to the satisfaction of the Program/Project Manager.
 - b. Provide materials and work necessary to correct out of tolerance drilled shafts, including engineering analysis and redesign, at no increase in the Contract Price, and without an extension of the completion dates for the Contract.

3.09 ADJUSTING

- A. During the construction of the drilled concrete shafts, if the Program/Project Manager determines that the equipment, materials, personnel, or procedures are such that defects in the work may occur, stop the Work until appropriate changes to correct the defects are made by the Contractor.

3.10 WASTE MANAGEMENT:

- A. Remove surplus excavated material and slurry.
- B. Fluids in contact with groundwater, soils removed below the groundwater table, and groundwater removed from the drilled shaft excavation that show evidence of suspected contamination due to odors, stained soil or water, and/or other similar indicators will need to be containerized and stored onsite until environmental characterization tests are completed.
- 1. The Program/Project Manager, through the City of Phoenix Aviation Department Planning and Environmental Division, will determine the type and frequency of these environmental characterization tests.



- a. At the discretion of the City of Phoenix Aviation Department Planning and Environmental Division, data referencing possible pre-existing contaminated soil and groundwater locations may be provided by the City to the Contractor.
 2. After the results of the environmental characterization tests are available, remove and dispose of these materials from the Site in accordance with applicable environmental regulations.
- C. Legally dispose of all slurry and surplus excavated material offsite at an approved disposal site.

3.11 PROTECTION

- A. Protect exposed ends of reinforcing steel bars, dowels, and anchor bolts from mechanical damage and exposure to the weather.

3.12 ATTACHMENTS

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
1. Final Concrete Mix Design Submittal Form.
 2. Test Results Submittal Form.

END OF SECTION

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM

(One for each required mix design)

PROJECT: _____ Location: _____

Contractor: _____

Mix design no.: _____ Design strength: _____

USE (Describe): _____

Mix Design Preparation: Based on Standard Deviation Analysis: _____

(check one) or Based on Trial Mixture Test Data: _____

MATERIALS:

Aggregates: (Provide size, type, source, specification)

Coarse: _____

Fine: _____

Cement Type/Source: _____

Admixtures: (Provide product, manufacturer)

Water Reducer (WR): _____

Air Entraining (AE): _____

Accelerator: _____

Other: _____

CONCRETE PROPERTIES

Water/Cement Ratio: _____

Slump: _____ inches

Entrained Air: _____ %

Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate: _____

Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement

W. R. _____ oz. per 100# cement

A. E. _____ oz. per 100# cement

Other _____ oz. per 100# cement

MIX PROPORTIONS

	Weight (lbs)	Absolute Volume (cubic feet)
Cement:	_____	_____

Fine Aggregate:	_____	_____
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Coarse Aggregate:	_____	_____
----------------------	-------	-------

Water:	_____	_____
--------	-------	-------

Entrained Air:	_____	_____
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Other:	_____	_____
--------	-------	-------

TOTAL	_____	_____
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TEST RESULTS SUBMITTAL FORM

METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318/318R, ACI 301):

Number of Test Cylinders Evaluated: _____ Standard Deviation: _____
(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

$$f'_{cr} = f'_c + 1.34s = \text{_____ psi}$$

$$f'_{cr} = f'_c + 2.33s - 500 = \text{_____ psi}$$

$$\text{Actual } f'_c = \text{_____ psi} \quad (\square f'_{cr})$$

$$\text{Slump} = \text{_____ in.} \quad \text{Air Content} = \text{_____ \%}$$

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318/318R □ 5.3.2.2):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	=====	=====	=====
28-day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$$\begin{array}{ll} f'_{cr} = f'_c + 1200 \text{ psi} & (\text{for } f'_c \square 5000 \text{ psi or less}) \\ \text{or} \quad f'_{cr} = f'_c + 1400 \text{ psi} & (\text{for } f'_c > 5000 \text{ psi}) \end{array}$$

$$\text{Slump} = \text{_____ in.} \quad \text{Air Content} = \text{_____ \%}$$

REMARKS: _____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable).

SUBMITTED BY:

Ready-Mix Supplier: Name _____

Address: _____

Phone Number: _____



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition.
1	03/02/2018	N/A	All	Second Edition



SECTION 02582

UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for underground electrical work, materials, products, and raceway systems.
- B. Related Requirements:
 - 1. Section 01180 - Project Utility Sources.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 01568 - Temporary Tree and Plant Protection.
 - 5. Section 02316 - Trenching and Backfill.
 - 6. Section 03100 - Concrete Forms and Accessories.
 - 7. Section 03200 - Concrete Reinforcement.
 - 8. Section 03300 - Cast-In-Place Concrete.
 - 9. Section 03410 - Plant-Precast Structural Concrete.
 - 10. Section 16050 - Basic Electrical Materials and Methods
 - 11. Section 16061 - Electrical Grounding and Bonding.
 - 12. Section 16130 - Raceway and Boxes.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AWG: An acronym for American Wire Gauge, a standard system for designating aluminum and copper electrical wire sizes as specified in ASTM B 258.
 - 2. PVC: Polyvinylchloride plastic material.
 - 3. PVC/GRSC: Polyvinylchloride coated galvanized rigid steel conduit.
- B. Definitions:
 - 1. Definitions for all items are as stated in NFPA 70, IEEE C2, and other reference documents listed unless otherwise stated, specified, or noted.
 - 2. Perm: A standard unit of permanence relating to the rate of water vapor transition through a specimen coating defined as follows:

$$\text{Perms} = \frac{(\text{Weight of water in grams})}{[(\text{Test duration in hours}) \times (\text{Specimen area in square feet}) \times (\text{Vapor pressure difference from one side of the specimen to the other in inches of mercury})]}$$



C. Reference Standards:

1. American Public Works Association (APWA):
 - a. APWA Public Works Management Practices Manual.
2. ASTM International (ASTM):
 - a. ASTM A 27/A 27M - Standard Specification for Steel Casings, Carbon, for General Application.
 - b. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - c. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
 - d. ASTM A 48/A 48M – Standard Specification for Gray Iron Castings.
 - e. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. ASTM A 283/A 283M – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - g. ASTM A 536 – Standard Specification for Ductile Iron Castings.
 - h. ASTM B 3 – Standard Specification for Soft or Annealed Copper Wire.
 - i. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - j. ASTM B 258 - Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors.
 - k. ASTM C 33 - Standard Specification for Concrete Aggregates.
 - l. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
 - m. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.
 - n. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
 - o. ASTM C 387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - p. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - q. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - r. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - s. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
3. Arizona Revised Statutes (ARS):
 - a. Chapter 2, Article 6.3, Underground Utilities, ARS 40-360.21 through 32.
 - b. Chapter 2, Article 6.4, Overhead Powerline Safety Law, ARS 40-360.41, 45.
4. International Electrical Testing Association (NETA):



- a. NETA ATS-2007 - Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
6. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C2 - National Electrical Safety Code.
 - b. ANSI/IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements.
7. Society of Cable Telecommunications Engineers (SCTE):
 - a. SCTE 77 – Specification for Underground Enclosure Integrity.
8. Underwriter's Laboratories Inc. (UL).
 - a. UL Listed supporting systems.
 - b. UL 6 – Electrical Rigid Metal Conduit – Steel.
 - c. UL 514A – Metallic Outlet Boxes.
 - d. UL 514B – Conduit, Tubing, and Cable Fittings.
 - e. UL 514C – Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
 - f. UL 514D – Cover Plates for Flush-Mounted Wiring Devices.
 - g. UL 651 – Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - h. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit.
 - i. UL 1242 - Standard for Electrical Intermediate Metal Conduit – Steel.
9. U. S. Government:
 - a. U. S. General Services Administration (GSA):
 - 1) Commercial Item Descriptions:
 - a) A-A-1923A - Shield Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors).
 - b) A-A-60005 – Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole [*Cancelled 3/6/2008 without replacement*].
 - c) AA-59544 – Cable and Wire, Electrical (Power, Fixed Installation).
 - 2) Federal Specifications:
 - a) FF-S-107C (2) - Screws, Tapping and Drive [*inactive*].
 - b. Federal Aviation Administration (FAA):
 - 1) FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment.
 - 2) FAA-C-1391 Installation and Splicing of Underground Cables [*drawing*].
 - c. Department of Defense (DOD):
 - 1) Military Specifications:
 - a) MIL-P-21035 – Paint High Zinc Dust Content, Galvanizing Repair (Metric).



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Incoming Service Requirements:

- a. Coordinate the Work of this Section and other work requirements with the Servicing Utility Company and the Owner prior to installation.
- b. For electrical service installation requirements and to verify exactly the work required by the utility company to be performed under this Contract, contact the representative of the Arizona Public Service Company (APS) listed in Section 01180, Project Utility Sources.

2. Excavation Safety:

- a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - 3) Take responsibility for locating existing utilities within the work area prior to excavation.
 - a) Where underground electrical work must cross existing utilities, no splices in the existing cables are allowed except as specified on the Contract Drawings; and installation of new cable must proceed as follows: Existing cables must be located manually.
 - b) Unearthed cables must be inspected to assure absolutely no damage has occurred.
 - c) Excavations in cable areas may only proceed with the approval of the Program/Project Manager, and possible damage or disruption of existing cable must be minimized by careful backfilling in the area of cable.
 - d) In the event that any previously identified cable is damaged during the course of construction, take responsibility for the complete repair.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - 1) Where existing active cables cross proposed installations, insure that these cables are adequately protected.
 - c. Provide suitable protection against bodily injury.
- ##### 3. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.



- a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
- b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Junction boxes and covers
 - 2) Conduit and conduit fittings by type.
 - 3) Corrosion-resistant handholes.
 - 4) Precast manholes.
 - 5) Precast handholes.
 - 6) Manhole frames and covers.
 - 7) Handhole frames and covers.
 - 8) Sump pumps.
 - 9) Waterproof mortar design mix.
 - 10) Conduit spacers and locking collars.
 - 11) Ductbank cable shields.
 - 12) Grade rings.
 - 13) Raceway identification tags.
 - 14) Pull rope.
 - 15) Detectable warning tape.
 - 16) Manways and associated hardware.
 - 17) Manhole ladders and hardware.
 - b. Shop Drawings:
 - 1) Ductbank.
 - 2) Installation details.
 - c. Samples:
 - 1) Warning tape.
 - d. Certificates:
 - 1) Precast handholes, manholes, and accessories.
 - 2) Handhole and manhole frames and covers.
 - 3) Sump pumps.
 - 4) Manhole waterproofing.
 - e. Delegated Design Submittals:
 - 1) Structural calculations for precast structures.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Packaged dry mortar manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Testing and Inspection Agency:
 - a. To perform testing and inspections, the Phoenix Sky harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 1. Testing and Inspection Agency Qualifications:
 - a. Employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements.
- C. Certifications:
 1. Submit a manufacturer's Certificate of Compliance for each of the following products provided, certifying that they meet or exceed the Contract requirements:
 - a. Precast handholes, manholes, and accessories.
 - b. Handhole and manhole frames and covers.
 - c. Sump pumps.
 - d. Manhole waterproofing:
 - 1) Submit the manufacturer's certification and test reports from a Testing and Inspection Agency acceptable to the Program/Project Manager proving that the proposed waterproofing meets or exceeds the Contract requirements, and has been in successful commercial use on structures of a similar type for at least 5 years.
- D. Preconstruction Testing:
 1. Ascertain the type of soil or rock to be excavated before bidding for this Contract.
 2. Provide only materials and equipment tested and listed by Underwriters Laboratories, Inc. (UL), when such equipment is listed or approved by UL.
 - a. Provide products that are listed and labeled by Underwriters Laboratory (UL) for the location installed in, and the application intended, unless products meeting the requirements of UL are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet Underwriters Laboratory (UL) quality verification requirements, including UL listing and labeling requirements.



- a) Such evidence may consist of either a printed mark on the data or a separate listing card.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials and equipment in a clean condition.
 - a. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.
 2. Provide equipment needed for unloading operations, and have such equipment on the Site to perform unloading work when the material and equipment is delivered.
 - a. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.
 - b. In the absence of pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.
 3. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by manufacturers.
 4. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Handle materials and equipment in accordance with the manufacturer's written instructions.
 2. Store all products whether on-site or off-site, indoors on blocking or pallets.
 3. Follow the manufacturer's written instructions for storing the items.
 4. Except for electrical conduit, store electrical equipment and products under cover in warehouses or in enclosed buildings that provide protection from the weather on all sides and properly condition the storage space.

PART 2 PRODUCTS

2.01 UNDERGROUND ELECTRICAL SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Use of Trade Names:
 - 1) The use of trade names in the Contract Documents is intended to establish a basis of design, constructability, and the level of quality required.



- 2) The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to the other manufacturers' products complying with all Contract requirements.

B. Description:

1. Underground electrical manholes, handholes, and ductbank Work includes performing surveying and providing survey markers to properly locate the Work, performing necessary excavations, providing electrical raceway and spacers, pull cords, raceway identification tags, detectable warning tape, and concrete encasement as indicated in the Contract Documents.

C. Design Criteria:

1. Design Frame and Cover Loading:
 - a. Provide manhole and handhole frames and covers for airside applications designed to withstand loads as follow:
 - 1) Maximum Tire Pressure: 205 psi.
 - 2) Maximum Vertical Main Gear Ground Load (V_{MG}): 82,100 pounds.
 - 3) Maximum Load per Tire: 41,050 pounds.
2. Shop Drawings:
 - a. Prepare Shop Drawings of the ductbank network showing locations, duct configurations, sizes, installation details, and concrete cover and reinforcement details.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
3. Calculations:
 - a. Have a registered Structural Engineer perform structural calculations for the precast structures to be provided under this Section.
 - b. Submit the structural calculations to the Program/Project Manager for approval.

D. Components

1. Junction Boxes and Covers:
 - a. Cast Iron Junction Boxes and Covers:
 - 1) Provide weatherproof and watertight cast iron junction boxes having a checkered cover and a neoprene gasket suitable for flush mounting.
 - 2) Size:
 - a) Provide 8-inch by 8-inch minimum junction boxes or larger if required by the NFPA 70, if indicated on the Contract Drawings, and/or required by field conditions.
 - 3) Manufacturers:
 - a) Appleton, www.appletonelec.com.
 - b) Cooper Crouse Hinds, www.crouse-hinds.com.
 - c) Hubbell Killark, <http://www.hubbell-killark.com>.
 - d) Equivalent approved by the Program/Project Manager..



- b. Nonmetallic Junction Boxes and Covers:
 - 1) Provide nonmetallic boxes and covers complying with the requirements specified in UL 514C.
- c. Submit the junction boxes and covers to the Program/Project Manager for approval.
- 2. Conduit, Conduit Fittings, and Conduit Spacers:
 - a. Provide conduit and raceway appropriate for the application as indicated in NFPA 70.
 - b. Provide the type of conduit and tubing as indicated on the Contract Drawings, and conforming to the requirements of Section 16130, Raceway and Boxes and the following:
 - 1) Intermediate Metal Conduit:
 - a) Provide intermediate metal conduit (IMC) complying with the requirements specified in UL 1242.
 - 2) Rigid Metal Conduit:
 - a) Provide rigid metal conduit complying with the requirements specified in UL 6.
 - 3) Nonmetallic Conduit:
 - a) For direct burial, provide rigid polyvinyl chloride (PVC) conduit complying with the requirements specified in UL 651 and and Article 352, *Rigid Polyvinyl Chloride Conduit: Type PVC*, of NFPA 70.
 - b) For concrete encased conduit, provide either Type EB and A rigid polyvinyl chloride (PVC) conduit complying with the requirements specified in UL 651A and Article 352, *Rigid Polyvinyl Chloride Conduit: Type PVC*, of NFPA 70, or Schedule 80 high density polyethylene (HDPE) conduit complying with the requirements specified in ASTM D 3350.
 - c) Provide the following types of nonmetallic conduit where indicated on the Contract Drawings:
 - (1) Type I: Provide Schedule 40 PVC conduit suitable for underground use either direct-buried or encased in concrete and for use as electrical system drain pipes.
 - (2) Type II: Provide Schedule 40 PVC conduit suitable for either above ground or underground use.
 - (3) HDPE: Provide high density polyethylene conduit suitable for directional boring without the need for protective sleeves
 - d) Provide the type of adhesive for nonmetallic conduit and fittings as recommended by the conduit/fitting's manufacturer.
 - 4) Split Conduit:
 - a) Provide steel or plastic split conduit pre-manufactured for the intended application.
 - 5) Conduit Fittings:



- a) Provide fittings for conduit and cable complying with the requirements specified in UL 514B.
 - c. Conduit Spacers and Locking Collars:
 - 1) Provide a conduit spacer system that consists of base spacers, intermediate spacers, and top spacers specifically designed to provide a completely enclosed and locked-in conduit assembly, and complete with interlocking cap and base pads or locking collars.
 - 2) Provide spacers compatible with the conduit utilized and conforming to those specified in other Sections of the Specifications.
 - 3) Provide prefabricated high grade, high density polyethylene double wall raceway spacers that interlock vertically and horizontally, and that are sized to create the specified spacing between raceways.
 - 4) Provide conduit spacers having sufficient strength to prevent displacement of the conduits when backfill is placed or concrete for encasement is poured.
 - a) Provide conduit spacers designed to accept vertically installed Number 4 reinforcing bars.
 - 5) Manufacturers:
 - a) Lamson and Sessions, Carlon®, www.carlon.com/Utility.
 - b) PW Eagle, Inc., www.pweagleinc.com/literature/e/.
 - c) Equivalent approved by the Program/Project Manager.
 - d. Submit the conduit, conduit fittings, conduit spacers, and locking collars to the Program/Project Manager for approval.
- 3. Corrosion-Resistant Handholes:
 - a. Provide corrosion-resistant handholes complying with the requirements specified in SCTE 77.
 - 1) Dimensions: 12 inches wide by 24 inches long.
 - 2) Unless otherwise indicated in the Contract Documents, provide handholes having a closed bottom.
 - 3) Provide handholes designed for flush burial.
 - b. Manufacturers:
 - 1) Armorcast Products Company, www.armorcastprod.com.
 - 2) Carson Industries LLC, www.carsonind.com.
 - 3) CDR Systems Corporation, www.cdrsystems.com.
 - 4) NewBasis, www.newbasis.com.
- 4. Ductbank Cable Shields:
 - a. Where cables enter and leave manholes, handholes, and other ductbank entrances provide suitable shields of a type manufactured for the purpose of protecting the cables such as end bells or other terminators.
- 5. Grade Rings:



- a. Provide precast grade rings designed for adjusting manholes to the proper grade.
6. Manhole/Handhole Frames and Covers:
 - a. Provide cast-iron or steel frames, covers, and gratings complying with the requirements of RR-F-621C and the following:
 - 1) Ductile Iron Cast Frames:
 - a) Provide ductile iron and austempered ductile iron castings that comply with the requirements specified in ASTM A 536.
 - 2) Gray Iron Cast Frames:
 - a) Provide gray iron castings that comply with the requirements specified in ASTM A 48/A 48M.
 - 3) Malleable Iron Cast Frames:
 - a) Provide malleable iron castings that comply with the requirements specified in ASTM A 47/A 47M.
 - 4) Steel Cast Frames:
 - a) Provide steel castings that comply with the requirements specified in ASTM A 27/A 27M.
 - 5) Structural Steel for Frames:
 - a) Provide structural steel that complies with the requirements for Grade D specified in ASTM A 283/A 283M.
 - b. Bolts and Anchors:
 - 1) Provide anchoring devices for fastening manhole/handhole frames to solid masonry or concrete.
 - 2) Manhole Frame Bolts:
 - a) Provide manhole frame bolts as required by the manhole frame and cover manufacturer.
 - b) Provide bolts of sufficient length to properly pass through any leveling units used to adjust to grade, and to engage the full depth of the inserts in the manhole top section.
 - c) Provide bolts of sufficient length to allow enough of the threaded end to pass through the manhole frame to allow properly tightening of the fastening nut and washer.
 - c. Preformed Sealing Compound:
 - 1) Provide a 2-inch thick preformed plastic sealing compound for sealing the perimeter of manhole/handhole frames.
 - d. Provide weatherproof covers secured by tamper-resistant locking devices.
 - 1) Color of Frame and Cover: Gray.
 - 2) Cover Finish: Non-skid finish with a minimum coefficient of friction of 0.50.
 - 3) Cover Legend: Molded lettering "ELECTRIC" OR "TELEPHONE".
 - e. Submit manhole/handhole frames and covers to the Program/Project Manager for approval.
7. Precast Concrete Electrical Manholes/Handholes:



- a. Provide watertight, precast concrete electrical manholes/handholes where indicated on the Contract Drawings.
 - 1) Make the precast units watertight by placing mortar or bitumastic sealer between their joints.
- b. Provide electrical manholes/handholes complete with the necessary, required, and specified appurtenances, such as watertight locking type covers, cable racks, pulling-in irons, ground rods, ladders, and provisions for water drainage.
 - 1) Ensure that the cable racks, including hooks and insulators, are sufficient to accommodate the cables, and are spaced not more than 24 inches horizontally.
 - 2) Provide wall brackets of glass reinforced nylon channel.
 - 3) Provide support brackets of glass reinforced nylon and of the removable type.
 - 4) Provide insulators of dry-process glazed porcelain.
 - 5) Pulling-In Irons:
 - a) Where required for pulling cables, provide a sufficient number of inserts for the proper attachment of cable supports in the walls of the manholes and handholes.
 - b) Provide steel bar pulling-in irons bent in the configuration of a deformed "Z", and cast in the manhole/handhole walls and floors; or provide 7/8-inch diameter hot-dipped galvanized steel or 7-strand, 1/2-inch diameter stress-relieved carbon steel roping having an ultimate strength of 270,000 psi designed for concrete applications.
 - (1) If stress-relieved carbon steel roping is provided, provide a rustproof sleeve installed at the hooking point, and encapsulate the exposed surfaces with a polyester coating to prevent corrosion.
 - (2) If steel bar pulling-in irons are provided, zinc-coat the pulling-in irons after fabrication.
 - c) Locate the pulling-in-irons so they do not interfere with the cable distribution racks.
 - (1) For pulling irons located in the floor, position the pulling irons in pockets centered directly under the manhole cover.
 - (2) For pulling irons located in the walls, position the pulling irons opposite the conduits entering the manhole and not less than 6 inches above or below those.
 - (3) Provide pulling-in irons that project approximately 4 inches into the manhole.
 - (4) Locate the pulling irons so they do not interfere with the cable distribution racks.



- 6) Where required for pulling cables, provide a sufficient number of inserts in the walls of the manholes/handholes for the proper attachment of cable supports.
 - c. In the floor of each manhole, provide a 1-inch diameter hole for installation of a ground rod.
 - d. Manhole Ladders:
 - 1) Provide fiberglass ladders for new manholes fabricated for use in underground electrical structures.
 - 2) Securely bolt the ladders to the concrete structure at or near the top and bottom of the ladders.
 - e. Manufacturers:
 - 1) Provide precast concrete manholes/handholes from the manufacturers indicated on Contract Drawings, or
 - 2) Equivalent approved by the Program/Project Manager.
 - f. Submit Product Data for the precast manholes, precast handholes, manhole frames and covers, and handhole frames and covers to the Program/Project Manager for approval.
 8. Pull Rope:
 - a. Provide 200 pound test nylon or polypropylene pull rope.
 - b. Submit the pull rope to the Program/Project Manager for approval.
 9. Raceway Identification Tags:
 - a. Provide brass tags inscribed or stamped with the raceway number, and having a sunlight resistant nylon tie for attaching the tag to the raceway.
 - b. Submit the raceway identification tags to the Program/Project Manager for approval.
 10. Sump Pumps:
 - a. Provide sump pumps for manholes where and as indicated on the Contract Drawings.
 - b. Submit the sump pumps to the Program/Project Manager for approval.

2.02 MATERIALS:

- A. Backfill Materials:
 1. Provide backfill material complying with the requirements specified in Section 02300, Earthwork, and Section 02316, Trenching and Backfilling; except do not provide backfill larger than 4 inches in diameter.
 2. Pea Gravel:
 - a. Provide gravel complying with the requirements specified in ASTM C 33.
 - 1) Provide coarse aggregate gradation conforming to the requirements for Size Number 57.
- B. Cable and Wire:
 1. Electrical Power Conductors:



- a. Provide electrical power conductors complying with the requirements specified in AA-59544.
 - b. Provide soft or annealed copper wire complying with the requirements specified in ASTM B 3.
 - c. Provide concentric-lay-stranded copper cable complying with the requirements specified in ASTM B 8.
- C. Concrete:
 - 1. Provide concrete conforming to the requirements for Class AA concrete (4000 psi compressive strength at 28 Days) specified in Section 03300, Cast-In-Place Concrete, except using 3/4-inch maximum coarse aggregate and having a slump of 7 inches plus or minus 1 inch.
- D. Concrete Reinforcement:
 - 1. Provide concrete reinforcement complying with the requirements specified in Section 03200, Concrete Reinforcement
- E. Waterproofing for Conduit Joints:
 - 1. For Rigid Metal Conduit and Fittings:
 - a. Provide cleaning solvent and thread sealant as recommended and approved by the conduit manufacturer.
 - 2. For Non-Metallic Conduit and Fittings:
 - a. Provide cleaning solvent and all weather, quick-set joint cement approved by the conduit manufacturer.

2.03 MIXES:

- A. Waterproof Mortar:
 - 1. Packaged Dry Mortar:
 - a. Provide Type M packaged dry mortar complying with the requirements of ASTM C 387.
 - b. Submit the packaged dry mortar manufacturer's installation instructions.
 - 2. Hydrated Lime:
 - a. Provide Type S hydrated lime complying with the requirements of ASTM C 207.
 - 3. Mortar Aggregate:
 - a. Provide mortar aggregate complying with the requirements of ASTM C 144.
 - 4. Water:
 - a. Provide clean and potable water.
 - 5. Moisture-Resistant Admixture:
 - a. Provide water repellent compound designed to reduce capillarity.
 - b. Manufacturers:
 - 1) W. R. Grace and Co., Dry-Block, www.na.graceconstruction.com.
 - 2) Solomon Grind-Chem, Inc., SGS Block-Ade.



- 3) BASF SE., Rheomix Rheopel, www.basf-admixtures.com/en/.
- 4) Equivalent approved by the Program/Project Manager..
6. Submit Product Data for the waterproof mortar design mix that indicates whether the Proportion or Property specification of ASTM C 270 is to be used, and also include required environmental conditions and admixture limitations.

B. Finishes:

1. Primer Materials:
 - a. Provide zinc chromate primer compatible with the enamel finish material.
2. Finish Materials:
 - a. Enamel:
 - 1) Provide synthetic exterior gloss enamel compatible with the zinc chromate primer.
 - b. Bitumastic Coating:
 - 1) Provide a coal-tar-based bitumastic coating with a vapor resistance of at least 0.5 perms.
 - c. Sunlight Protective Inhibitor:
 - 1) Provide a sunlight protective inhibitor compatible with the bitumastic coating.
 - d. Galvanizing Repair Compound:
 - 1) Provide a liquid cold-galvanizing compound complying with the requirements specified in MIL-P-21035.
3. Shop Finishing Methods:
 - a. Hot-dip galvanize all metal-work after fabrication that is installed within manholes, including steel ships ladders, in accordance with ASTM A 123/A 123M to the thicknesses specified therein.

2.04 ACCESSORIES

- A. Provide those accessory products, such as building wire, connectors, fittings and similar devices, required for performing the Work of this Section as specified in other Specification Sections.
- B. Grounding and Bonding Materials:
 1. Provide grounding and bonding materials conforming to the requirements of Section 16060, Grounding and Bonding.
 2. Provide copper clad steel ground rods having a diameter adequate to permit driving the full length of the rod minus 6 inches, which extends above the finished concrete slab.
 3. Provide 600 Volt ground wires sized as indicated or required by code, but not less than 6 AWG.
- C. Hangers, Supports, and Fasteners:
 1. Supporting Devices:



- a. Provide field-fabricated support systems for electrical equipment.
 - b. Pre-engineered UL-listed supporting systems fabricated from electrogalvanized steel or PVC-coated electrogalvanized steel may be provided in lieu of field-fabricated support systems.
2. Structural Angles, Channels, and Bars:
 - a. Provide steel angles, channels, and bars fabricated from steel conforming to the requirements of ASTM A 36/A 36M.
3. Fasteners:
 - a. To anchor conduit, raceway, supporting devices, or pre-engineered supporting systems to the structures, provide anchoring devices of the type specifically designed for anchoring into the structure materials.
 - 1) Toggle and Expansion Bolts:
 - a) Provide toggle and expansion bolts conforming to the requirements of FF-B-588C.
 - 2) Self-Tapping Screws:
 - a) Provide self-tapping screws conforming to the requirements of FF-S-107C(2).
 - 3) Expansion Anchors:
 - a) Provide anchoring devices for fastening into solid masonry or concrete conforming to the requirements Type 4 as specified in A-A-1923A.
 - b) Rawl plugs are unacceptable.
- D. Warning Tape:
 1. Provide detectable warning tape consisting of acid and alkali resistant printed polyethylene film, 4 mils thick minimum, and having an overcoated legend with one-inch high minimum lettering manufactured for marking and identifying underground utilities.
 2. Detection Device:
 - a. Provide a metallic core encased in a protective jacket for corrosion protection, and detectable by a metal detector when the tape is buried up to 30 inches deep.
 3. Legends:
 - a. "CAUTION-BURIED ELECTRIC LINE" for ductbank containing electric lines.
 - b. "CAUTION - BURIED TELEPHONE LINE" for ductbank containing telephone lines.
 - c. For ductbank containing both electric and telephone lines, the legend can contain both the "CAUTION-BURIED ELECTRIC LINE" and "CAUTION - BURIED TELEPHONE" messages.
 4. Color:
 - a. Provide underground warning tape colors per the APWA Uniform Color Code as described in the APWA Public Works Management Practices Manual.
 - 1) Electric: Red.
 - 2) Telephone and other communications: Orange.



5. Manufacturers:
 - a. Brady, www.bradyid.com.
 - b. Seton, <http://www.seton.com>.
6. Submit Product Data for the detectable warning tape and a Sample of the proposed warning tape to the Program/Project Manager for approval.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Notify the Program/Project Manager of unexpected subsurface conditions, and discontinue working in the affected area until notified to resume work.
- B. Pre-Installation Testing:
 1. Determine applicable soil-density relationships for bedding and compaction of backfill material for installing underground electrical ducts and manholes as indicated in Section 02316, Trenching and Backfill.
- C. Evaluation and Assessment:
 1. If raceway runs cannot be installed as shown because of conditions not discoverable prior to trenching, refer the condition to the Program/Project manager for direction before performing further work.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Provide and maintain protection to retain earth banks and to protect adjoining grades and structures from caving, sliding, sloughing, erosion, or other damage.
 2. Protect trees, shrubs, and other features remaining as a portion of final landscaping in accordance with Section 01568, Temporary Tree and Plant Protection.
 3. Protect benchmarks, utilities, paving, and curbs from equipment and vehicular traffic.
 4. Protect any above-grade and below-grade utilities which are to remain.
- B. Surface Preparation:
 1. For ducts installed in or under pavement surfaces, neatly saw cut the pavement surfaces to form a vertical face.
 2. Perform earthwork excavation for buried conduit, manholes, and handholes as required and specified in Section 02316, Trenching and Backfill.
 - a. Excavated the trenches for conduits and duct banks either manually or using mechanical trenching equipment unless they are in pavement, in which case excavate the trenches using only mechanical trenching equipment.



- 1) Perform the excavation for structures and structure footings to the lines and grades or elevations shown on the Contract Drawings.
- 2) Provide excavations sufficient to permit the full width and length of the structure or structure footings shown on the Contract Drawings to be placed.
- 3) Before beginning to place concrete for duct banks, open the complete length of the trench so obstructions can be discovered, and proper provisions can be made to avoid them.
- 4) Remove boulders, logs, and other objectionable material encountered in the excavation.
 - a) If rock is encountered during excavation, remove the rock to a depth of at least 3 inches below the required conduit or duct bank depth.
 - (1) Clean rock and other hard foundation material of all loose material, and cut the material to a firm surface either level, stepped, or serrated as directed by the Program/Project Manager.
 - (2) Replace the removed rock with bedding material consisting of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve, or with flowable backfill.
 - b) Remove seams, crevices, disintegrated rock, and thin strata.
- 5) If the soil encountered at the established ductbank grade is an unsuitable material as determined by the Program/Project Manager, either remove the unsuitable material and replace the removed material with suitable material, or provide additional ductbank supports approved by the Program/Project Manager that are adequate and stable.
 - b. If concrete is to rest on a surface other than rock, take special precautions not to disturb the bottom of the excavation
 - 1) Do not excavate to the final grade until just before the concrete or reinforcing is to be placed.
 - c. Ensure that a minimum of shoulder surface is disturbed by keeping the walls of the trenches essentially vertical.
 - d. Do not use the blades of graders to excavate the trenches.
 - e. After each excavation is completed, notify the Program/Project Manager.
 - 1) Place structures only after the Program/Project Manager has approved the depth of the excavation and the suitability of the foundation material.
3. Provide bracing, sheeting, and shoring as necessary to protect the Work and provide safety for personnel and comply with governing laws.
4. Provide a compacted base under the duct bank and other structures.



- a. Prior to installing structures, provide a minimum of 6 inches of sand or another material approved by the Program/Project Manager as a suitable base to receive the structure.
 - b. Compact the base material, and grade it level at the proper elevation to receive the structure in relation to the conduit grade or ground cover requirements indicated on the Contract Drawings.
5. Do not excavate trenches for electrical ductbanks wider than necessary to construct the nominal concrete encased ductbank.
 - a. If the trench walls are stable, the trench walls may be used to as forms for the concrete encasement.
 - b. If concrete formwork is required to support the trench, furnish formwork as specified in Section 03100, Concrete Forms and Accessories.
 - c. Adjust clearances to obtain at least the minimum concrete dimensions specified or indicated in the Contract Documents.
6. Clean excavations prior to placing raceway and concrete.
 - a. Remove water from excavations by pumping or other approved methods.

3.03 INSTALLATION

A. Underground Conduit Installation:

1. Install underground conduit systems in accordance with the requirements specified in Article 300.5, *Underground Installations*, of NFPA 70, the National Electrical Code (NEC); specified requirements exceeding those of NFPA 70; and in accordance with the requirements of this Section.
 - a. Provide the type raceway indicated on the Contract Drawings.
2. Provide and arrange raceways as indicated on the Contract Drawings.
 - a. Bank conduits together to the extent indicated on the Contract Drawings.
 - 1) On multiple conduit arrays, provide a conduit spacer system applicable to the type of conduit that maintains uniform conduit spacing.
 - a) Install the spacers in accordance with manufacturer's instructions.
 - b) For every 20 feet of 2-inch conduit array, provide a minimum of 5 spacer assemblies.
 - c) For every 20 feet of 4-inch and larger conduit arrays, provide a minimum of 4 spacer assemblies.
 - d) Prior to placing the concrete encasement, drive Number 4 reinforcing bars vertically into the soil to a minimum depth of 6 inches to anchor the assembly into the earth, and fasten the spacers down with locking collars attached to the vertical bars.
 - 2) Securely fasten conduits in place during construction, and plug them to prevent contamination from entering the conduits.



- a) Secure raceways to prevent displacement during concrete encasement or earth backfilling.
 - 3) Separate conduits by the minimum spacing or concrete thickness indicated on the Contract Drawings, or as specified.
 - 4) Stagger conduit couplings in banks of conduits to provide a duct bank having the maximum strength possible.
 - a) Stagger the joints of the conduits by rows and layers.
 - 5) Consider the bending radii indicated on the Contract Drawings and specified herein as minimums unless otherwise noted.
 - 6) Make minor changes in the location or cross section of ductbanks as necessary to avoid obstructions or conflicts.
 - 7) If raceway or ductbank terminates in a building, install the raceway under the building as a continuous ductbank.
3. Slope conduit lines away from buildings and to manholes or handholes for drainage, except keep those conduit lines that run between buildings without intervening handholes or manholes level.
 - a. Lay conduit lines so a minimum slope of 3 inches per 100 feet is maintained.
 - b. Slope conduit lines that run to manholes, handholes, or similar underground structures, so they drain to such underground structure.
4. Except at conduit risers, change the direction of bends in runs exceeding a total of 10 degrees, either vertical or horizontal, by providing long sweep bends having a minimum radius of curvature of 25 feet.
 - a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
 - b. Use only manufactured bends with a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter, and a minimum radius of 36 inches for conduits of 3 inches in diameter and larger.
5. If conduits change direction or turn up at equipment, transformers, buildings, terminal poles, and similar items, use long sweep PVC coated rigid galvanized steel conduit (RGSC) elbows unless otherwise indicated on the Contract Drawings or specified.
 - a. For polyvinyl chloride (PVC) conduit:
 - 1) If the bend radius is less than 6 feet, provide ells fabricated from galvanized rigid steel conduit or PVC/GRSC.
 - a) Minimum Bend Radius: 38 inches.
 - 2) If the bend radius is 6 feet or greater (90 degrees of bend in 9.5 feet of conduit length), provide bends fabricated from Schedule 40 PVC conduit.
 - a) Either factory ells or field bent bends may be provided.
 - (1) For field bends having radii less than 100 feet, hot form the bends using a heater recommended by the conduit manufacturer.
 - (a) For 2 inch and larger conduit, furnish plugs during bending.



- (b) Remove the plugs only after the conduit has cooled.
 - (2) For field bends having radii 100 feet and greater, cold form the bends.
 - (a) When placing cold bends, maintain adequate spacing from the inside of the bend to the wall of the excavation to permit the required 3 inches of concrete to be placed.
 - b. Split Ducts:
 - 1) When existing cables are to be placed in split duct encased in concrete, carefully locate and expose the cable by using hand tools.
 - a) Prior to placing the cables into the duct, notify the Program/Project Manager so the cable may be inspected to determine if it is in satisfactory condition by the Program/Project Manager.
 - 2) Where required, provide split duct as shown on the Contract Drawings, or as required by the Program/Project Manager.
 - c. Weld polyvinyl chloride (PVC) and high density polyethylene (HDPE) conduit as recommended by the conduit manufacturer.
6. Underground Conduit for Service Feeders:
- a. Underground conduit for service feeders into buildings are indicated on the Contract Drawings.
 - b. Where a rigid steel conduit bank is utilized, protect the ends of the conduit by threaded metal caps or brushings.
 - 1) Coat the threads with graphite grease or other suitable coating.
 - c. Clean and plug the conduit before conductors are installed.
7. For ducts terminating in pull boxes, manholes, and handholes as indicated on the Contract Drawings, provide ductbank cable shields.
8. Cap raceway ends.
- a. Prior to capping conduits, swab and mandrel the conduits.
9. Pull Cords:
- a. In each individual raceway installed, whether direct-buried or a part of a duct bank, provide a pull cord for pulling the permanent wiring or for future use; and secure the pull cord at each end of the raceway by tying the cord to the end cap.
 - b. Provide a pull rope in each telephone and spare conduit and ductbank.
 - 1) Plug the open ends of spare unused (empty) conduits with removable tapered conduit plugs designed for this purpose.
 - c. Secure the ends of the pull cords, and provide a minimum of 3 additional feet of pull cord at each end.
 - 1) Ensure that a sufficient length is left in access points to prevent the pull cord from slipping back into the conduit.
10. Raceway Identification:



- a. Identify each raceway at each end by attaching raceway identification tags inscribed or stamped with the raceway number shown on the Contract Drawings.
 - b. Attach the raceway identification tags to the raceway with a tie as specified
 - c. If the Contract Drawings do not show a raceway numbering scheme, develop the numbering subject to the approval of the Program/Project Manager.
- B. Concrete Encased Underground Duct Bank:
 1. If detailed on the Contract Drawings, encase both single and banked underground conduits in concrete reinforced in accordance with Section 03200, Concrete Reinforcement, with 5/8-inch steel reinforcing rods.
 - a. Install concrete encasement as indicated and detailed.
 - b. Coordinate placement of the concrete with other work.
 - c. If the ductbank conflicts with other work, relocate the ductbank as directed by the Program/Project Manager.
 2. Construct underground duct bank lines from individual conduits encased in concrete as indicated on Contract Drawings.
 - a. Except where rigid galvanized steel (RGS) conduit is indicated or specified, use only one kind of conduit in any one duct bank.
 - b. Provide ducts not less than 4 inches in diameter unless otherwise indicated on the Contract Drawings.
 3. Enclose all conduits in the bank within concrete encasement having a rectangular in cross-section.
 - a. Place concrete in accordance with the requirements of Section 03300, Cast-In-Place Concrete.
 - 1) Adjust the delivery chute so the direct fall distance of the concrete into the trench is 2 feet or less.
 - 2) Furnish a splash board to divert the flow of concrete away from the trench sides to avoid dislodging soil and stones.
 - b. Provide at least 3 inches of concrete cover between conduit ducts and the surface of the concrete encasement.
 - c. Separate conduits within the bank from one another by a minimum concrete thickness of 2-inches.
 - d. Maintain a minimum separation between conduit centerlines of 7-1/2 inches.
 - e. Minimize expansion and contraction of plastic raceway as concrete is placed by encasing there raceway from one end of the duct section toward the other end allowing the free end to move while the concrete is placed.
 - 1) Do not place concrete from each end toward the center of the ductbank.
 - f. If indicated in the Contract Documents, reinforce the bottom side and top of encasements with steel reinforcing mesh, or fabric, or other approved metal reinforcement.



4. Additional Requirements for Underground Duct Banks in Paved and Other Special Areas:
 - a. Where the ground is soft and boggy, where ducts cross under roadways, or where shown on the Contract Drawings, provide additional supports if required by the Program/Project Manager.
 - 1) If duct bank is subject to these conditions, support the complete duct structure on reinforced concrete footings, piers, or piles spaced at intervals approximately 5 feet apart.
 - b. Underground Duct Bank in Paved Areas:
 - 1) Where concrete encased underground duct bank is installed under runways, taxiways, aprons, or other paved areas, install duct banks so the top of the concrete envelope is not less than 18 inches below the bottom of the base or stabilized base course layers unless otherwise shown on the Contract Drawings.
 - 2) Where concrete encased underground duct bank is installed in unpaved areas, install duct banks so the top of the concrete envelope is not less than 18 inches below finished grade unless otherwise shown on the Contract Drawings.
 - 3) Unless otherwise shown on the Contract Drawings, extend duct banks that are under paved areas at least 3 feet beyond the edges of the pavement, or 3 feet beyond any underdrains that are installed alongside the paved area.
5. Unless otherwise indicated in the Contract Documents, separate electrical power conduits from telephone, communication, and/or data highway conduits by a minimum of 24 inches of earth or 8 inches of concrete.
6. For ductbank between manholes, handholes, and pullboxes, place concrete continuously.
 - a. If concrete placement must stop for more than 2 hours, place 8-foot lengths of Number 4 steel reinforcement bars longitudinally around the perimeter of the concrete envelope on 12-inch centers at the end of the ductbank, and provide a 2 inches minimum of concrete cover.
 - 1) Embed half of each 8-foot bar in each of the 2 pours, the pour stopped and the future pour.
7. At access points, provide end bells or couplings installed flush with the concrete encasement.
8. Where conduits turn up into equipment or transformer pads, extend the concrete encasement for the conduits up to the top of the concrete pad, and provide a 3/4 inch chamfer around exposed top edges.
 - a. Isolate the concrete encasement for the conduits from the concrete pad for the equipment or transformer pad by providing crushable fiber materials 2 inches high around the duct bank encasement.
 - b. Extend conduits 6 inches above the concrete slab surface.
 - c. Install an insulating grounding bushing on each conduit.
9. Where conduits turn up at terminal poles, extend the concrete encasement for the conduits up the pole to a height of 24 inches above



finished grade, and provide a 3/4 inch chamfer around all exposed top edges.

10. If concrete encased duct banks are terminated for future extension, stub out and cap all conduits at least 1 foot beyond the end of the ductbank concrete.
 - a. Protect the protruding ends of the conduit from damage while they are exposed.
 - b. To make extending the ductbank in the future easier, stagger the end of each horizontal row of conduit beginning at the top row of raceway
 - c. Extend the reinforcement steel to a point beyond all of the conduit ends, leaving at least 4 feet of each rebar embedded in the ductbank concrete.

C. Manhole/Handhole Installation:

1. Build concrete structures on prepared foundations conforming to the dimensions and form indicated on the Contract Drawings.
 - a. Provide formwork, concrete, and concrete reinforcement in accordance with the requirements specified in Section 03100, Concrete Forms and Accessories; Section 03200, Concrete Reinforcement; Section 03300, Cast-In-Place Concrete; and Section 03410, Plant-Precast Structural Concrete.
 - b. Install precast units so they are plumb and true.
2. Grade Adjustments:
 - a. Where openings into manholes are below the final finished grade, extend the openings up to the required elevation using either concrete or brick suitably arranged to support and/or anchor the manhole's frames and covers.
 - b. Obtain the Program/Project Manager's approval of the construction method and procedure before any work is performed.
3. Grounding Structures:
 - a. Except in concrete structures containing Federal Aviation Administration (FAA) facilities, provide a 3/4 inch diameter by 10 foot long copper clad ground rod through the 1 inch diameter hole in a corner of the floor of manholes/handholes and other concrete structures.
 - 1) Leave 6 inches of the ground rod extended above finished floor.
 - 2) Install the ground rod within 1 foot of a corner of the concrete structure.
 - 3) For cast-in-place bottom slabs, install the ground rods prior to casting the bottom slab.
 - 4) If the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, drill a 4-inch diameter hole into the earth to receive the ground rod.
 - 5) If the bottom slab of a precast structure does not have a hole for the ground rod, drill a hole through bottom slab, and then install the ground rod.



- b. Grounding Bus:
 - 1) Provide a grounding bus consisting of 4/0 AWG bare stranded copper wire exothermically bonded to the ground rod, and looped around the walls of concrete structures.
 - a) Mount the ground bus a minimum of 1 foot above the floor of the structure, and separate from other cables.
 - 2) Ground metal within the manhole to the ground rod.
 - a) Provide 2 AWG bare copper pigtails to bond the grounding bus to all cable trays and other metal hardware within the concrete structure.
 - (1) Provide exothermic welds to connect the pigtails to the grounding bus.
 - (2) Provide mechanical connections, consisting of a lug designed for that purpose, to connect the pigtails to hardware.
- c. Seal the hole through the floor around the ground rod.
 - 1) Fill the entire length of the hole around the ground rod below the slab with Portland cement grout.
 - 2) Seal bottom slab penetrations around the ground rod with Portland cement grout to make the penetration watertight.
- 4. Structure Drainage System:
 - a. Provide a manhole drainage system as indicated on the Contract Drawings.
- 5. Cable Supports:
 - a. Where cables enter and leave manholes, handholes, and other duct bank entrances, provide duct bank cable shields.
 - b. Install cable support brackets, along with the support arms and porcelain insulators, on each wall of the manhole and handhole.
 - 1) Take care not to damage the walls of the manholes and handholes during cable pulling.
 - 2) Install cable with proper regard for providing a neat and orderly appearance and location, and for providing accessibility for future connections.
 - 3) Properly dress and rack cable or wire on support arms and insulators around the walls of the manholes and handholes, providing slack where required for future rearrangements.
 - 4) Secure cables within manholes and handholes to the insulators by marlin rope.
- 6. Pulling Irons:
 - a. Provide pulling-in irons located opposite every conduit entrance into each structure to provide a strong, convenient attachment for pulling-in blocks used to install cables.
 - b. Set the pulling-in irons directly into the concrete walls of the structure.
- 7. Manhole Ladders:
 - a. Install ladders in accordance with the manufacturer's requirements.



- D. Connecting Concrete Encased Ductbank to Manholes/Handholes:
1. Adjacent to the manhole or handhole, provide a tapered section that provides shear strength to connect encased duct bank lines to manholes or handholes.
 2. Construct penetration openings through manhole and handhole walls with keyways to provide for keying the concrete envelope of the ductbank line into the wall of the manhole or handhole.
 3. To relieve stress at the joint between concrete-encased duct banks and structure walls, place reinforcement rods in the structure wall; and form and tie the reinforcement rods into the duct bank reinforcement when the duct bank is installed.
 4. Use vibrators when this portion of the envelope is poured to assure a seal between the ductbank envelope and the wall of the manhole or handhole.
- E. Cast Iron Junction Boxes:
1. Provide in-ground cast iron junction boxes installed flush with the surface at the locations indicated on the Contract Drawings.
 - a. Install cast iron junction boxes in concrete pads as detailed on the Contract Drawings.
- F. Manhole/Handhole Frames and Covers:
1. Install manhole/handhole castings, frames, and fittings in the positions indicated on the Contract Drawings, or as directed by the Program/Project Manager.
 - a. Set the castings, frames, and fittings true to line and at the correct elevation.
 - b. Unless otherwise indicated in the Contract Documents, make field connections using bolts; welding is not permitted unless shown on the approved Shop Drawings, and written permission to weld is granted by the casting manufacturer.
 - 1) Properly locate anchor bolts and anchors, and build them into the connection work.
 - 2) Preset the bolts and anchors using of templates or other methods to accurately locate the anchors and anchor bolts.
 - c. If the frames or fittings are to be set in concrete or cement mortar, place and position anchors or bolts before the concrete or mortar is placed.
 - d. Do not disturb the unit until the mortar or concrete has set.
 2. Where required, make the final adjustment of manhole/handhole frames to the proper elevation using precast grade rings.
 - a. Wet, but do not saturate, the precast grade rings immediately before laying them.
 - b. Pre-set the grade rings to the proper plane and elevation by using wedges or blocks of cementation material that do not exceed 1 square inch wide on each side to adjust the grade ring position.
 - 1) Do not use more than 4 wedges or blocks per grade ring.



- c. Set grade rings in waterproof mortar.
 - 1) Do not place mortar more than 3/4-inch or less than 3/8-inch thick.
 - 2) Incorporate the adjusting wedges or blocks in fresh mortar in a manner that completely encases each.
 - 3) Crown the fresh mortar to produce squeeze-out between grade rings.
 - d. Tool the exposed joints with an appropriately shaped tool, and compact the mortar edge into the joints between grade rings.
 - e. Clean off excess mortar prior to initial mortar set.
 - 3. After applying the preformed sealing compound on the bearing surface of the manhole frame, bolt the manhole frame in place on the manhole top section, or on leveling units.
 - a. Install and tighten the manhole frame bolts after the waterproof mortar has cured.
 - b. Remove excess sealing compound squeezed out after the manhole frame is bolted in place.
- G. Waterproofing:
 - 1. Construct underground conduit lines to be watertight.
 - 2. Waterproof conduit joints:
 - a. Solvent clean rigid metal conduit joints, and apply approved thread sealant.
 - b. Solvent clean non-metallic conduit joints, and apply approved joint cement.
 - 1) Liberally coat the end of Schedule 40 PVC plastic conduit before joining, then insert the conduit end into the coupling, push firmly, and rotate the conduit until it reaches the pre-formed stopping ridge within the coupling.
 - 3. Waterproof the precast concrete electrical manholes/handholes using approved waterproofing materials.
 - a. Provide watertight joints by applying sealant at each tongue-and-groove joint and at the roof of manholes.
 - 1) Remove excess sealant and surface projections on the exterior of the neck.
 - b. Apply a minimum of 2 coats of protective bitumastic coating to surfaces in direct contact with in ground cover in order to obtain a minimum total dry film thickness of 12.0 mils on the surfaces.
 - c. Apply the bitumastic coating in strict conformance with manufacturer's instructions.
 - d. Topcoat the bitumastic coating with a sunlight protective inhibitor.
- H. Backfilling:
 - 1. Unless otherwise indicated in the Contract Documents, remove bracing, sheeting and shoring involved in the construction of duct banks and other structures after the completion of the structures.



- a. Effect the removal in a manner that will not disturb or mar finished concrete and masonry.
 - b. Withdraw sheeting and bracing used to support the sides of trenches or other open excavations as the trenches or other open excavations are being refilled.
 - 1) Unless otherwise directed, withdraw the portion of the sheeting extending below the top of a structure before more than 6 inches of material is placed above the top of the structure and before any bracing is removed.
 - 2) Carefully refill the voids left by the sheeting with select material, and ram the select material tight with tools specially adapted for the purpose or as otherwise may be approved by the Program/Project Manager.
 - 3) The Program/Project Manager may require the Contractor to delay the removal of sheeting and bracing if, in the judgment of the Program/Project Manager, the installed work has not attained the necessary strength to permit placing backfill.
2. Ensure that trenches do not contain pools of water during backfilling operations.
3. Do not place backfill against a structure until the Program/Project Manager gives permission.
 - a. In the case of in-situ concrete, such permission will not be given until tests made by the Testing and Inspection Agency establishes that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.
4. After a structure has been completed, backfill the area around it in horizontal layers not to exceed 6 inches in thickness measured after compaction to the density requirements.
 - a. Deposit each layer all around the structure to approximately the same elevation.
 - b. In areas where the existing grade treatment is asphalt, continue placing backfill to within 3 inches of the finished grade; and complete the fill to grade with asphalt..
 - c. In areas of exposed earth continue placing backfill to the existing finished grade.
 - d. The top of the fill shall meet the existing elevation unless otherwise indicated on the Contract Drawings
5. Ensure that backfill is free from roots, wood, scrap material, and other vegetable matter and refuse.
6. Provide 2-1/2 feet minimum of backfill cover over conduits and over the concrete encasement of conduit, unless otherwise indicated in the Contract Drawings or specified.



7. Progress the backfilling and compaction as rapidly as the construction, testing, and acceptance of the Work permits, and in accordance with the requirements of Section 02300, Earthwork.
 - a. If required by the Program/Project Manager, add sufficient water during compaction to assure a complete consolidation of the backfill at no increase in Contract Price.
 8. Provide a continuous detectable warning tape about 12 inches below the top of the trench directly over each underground duct bank.
- I. Field Coating:
1. Frames, Covers and Gratings:
 - a. Clean mortar, rust, grease, dirt and other deleterious materials from cast-iron or steel frames, covers, and gratings not buried in concrete or masonry by an approved abrasive media blasting process, then coat the frames, covers, and gratings with bituminous coating material.
 - b. Clean surfaces that cannot be cleaned satisfactorily by abrasive media blasting to bare metal by wire brushing or another mechanical means.
 - 1) Thoroughly wash surfaces contaminated with rust, dirt, oil, grease or other contaminants with solvents until clean.
 - 2) Immediately after cleaning, coat the surfaces with a pretreatment coating or provide a crystalline phosphate coating.
 - 3) As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc chromate primer.
 - 4) Coat the primed surfaces with enamel.
 2. Dissimilar Surfaces Isolation:
 - a. Paint aluminum surfaces where they contact wood, concrete, or masonry construction with 1 coat of bituminous paint to provide a minimum dry mil thickness of 5.0 mils.
 - b. Clean away excess or misplaced paint materials from aluminum surfaces and adjoining construction materials.
- J. Grounding:
1. Provide non-current carrying metallic parts associated with electrical equipment with a maximum resistance to solid "earth" ground not exceeding the acceptable values listed under the Grounding Electrode System Tests in Article 3.05.
- K. Warning Tape:
1. In unpaved areas, install underground electrical warning (caution) tape in the trenches above the underground ductbanks and conduits.
 - a. Above the underground conduit or duct lines not installed under pavement, install detectable warning tape of the applicable color a minimum of 8 inches below grade.



2. If not otherwise indicated on the Contract Drawings, locate the warning tape 6 inches above the duct/conduit or the counterpoise wire if present.

3.04 REPAIR/RESTORATION

- A. Take responsibility for all damage or injury done to conduits, duct banks, structures, property, or persons due to improper placing or compacting of backfill.
- B. Restore the areas disturbed by the Work of this Section to their original condition or as otherwise indicated on the Contract Drawings.
 1. Take responsibility for maintaining the disturbed surfaces and replacements until Final Acceptance
- C. Grade around structures so positive drainage away from the structures is provided.
- D. In areas having special surface treatments, such as roads, sidewalks, or other paved areas, compact the backfill to match the surrounding areas; and repair the surfaces using materials comparable to the original materials.
- E. Repairing Galvanized Surfaces:
 1. After galvanized items have been erected, repair damaged areas by applying galvanizing repair compound.
 2. Prepare surfaces apply the repair compound in accordance with the manufacturer's recommendations.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Site Tests:
 - a. Grounding Electrode System Tests:
 - 1) Test Procedure:
 - a) In accordance with Paragraphs 7.13.1 and 7.13.2 of NETA ATS-2007, all made grounding electrode systems will be visually and mechanically inspected.
 - b) Prior to covering the installed products and energizing the electric service, the ground system resistance to earth will be measured with a ground megohmmeter by the Program/Project Manager.
 - c) All made grounding electrode systems will be electrically tested In accordance with Paragraphs 7.13.1 and 7.13.2 of NETA ATS-2007.
 - (1) For the point-to-point tests specified in Paragraph 7.13.2.1 of NETA ATS-2007, measurements are only required for



equipment conductors run with services, and for feeders and branch circuits rated over 400 Amperes.

- d) Each manhole ground rod will be tested in accordance with the fall-of-potential ground impedance test procedures specified in ANSI/IEEE 81 prior to establishing connections to other ground electrodes.
- 2) Acceptance Criteria:
 - a) Ground for the main service: 5 Ohms.
 - b) Ground grids for emergency/standby generators: 5 Ohms.
 - c) Ground buses for panelboards: 10 Ohms
 - d) Ground rod electrodes for manholes: 25 Ohms.
 - e) Grounds not otherwise indicated in this Section: 25 Ohms, maximum.
 - f) For continuity tests, the acceptable value for the equipment grounding conductor is determined from the following formula:

$$R_{\text{Equip Gnd Cond}} \leq 0.1 \times \left(\frac{V_{\text{Line To Gnd}}}{I_{\text{Over Current Protection}}} \right)$$

where

$R_{\text{Equip Gnd Cond}}$ = The measured resistance of the equipment grounding conductor.

$V_{\text{Line To Gnd}}$ = The nominal line to ground Voltage of the circuit or feeder.

$I_{\text{Over Current Protection}}$ = The trip, or melting current of the overcurrent protective device for the circuit.

b. Moisture/Density Tests:

1) Test Procedure:

- a) Where duct banks are installed under pavement, one moisture/density test will be performed for each lift in each 250 linear feet length of duct bank, or for each lift in one work shift, whichever is less.
- b) In-place field density tests will be performed in accordance with the methods specified in ASTM D 1556 or ASTM D 2922.
 - (1) If the methods of ASTM D 2922 are used for in-place field density testing, the moisture content will be determined as specified in ASTM D 3017.

2) Acceptance Criteria:

a) Aggregate Base:

- (1) Each layer of aggregate base course compacted to at least 98 percent of the maximum dry density as specified in ASTM D 698 have achieved acceptable compaction.



- b) Structural Fill and Granular Fill:
 - (1) Each layer of structural fill and granular fill that maintains the moisture content at compaction within 2 percentage points of optimum moisture content as determined in accordance with the requirements of ASTM D 698 have acceptable moisture content.
 - (2) Except for the upper 2 feet of structural fill and granular fill below pavement and slab areas, each layer of structural fill and granular fill below pavement and slab areas compacted to at least 95 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698 have achieved acceptable compaction.
 - (3) For structural fill and granular fill in the upper 2 feet below pavement and slab areas, each layer of fill compacted to at least 98 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698 have achieved acceptable compaction.
 - c) Non-structural Fill:
 - (1) Each layer of non-structural fill that maintains the moisture content at compaction within 3 percentage points of optimum moisture content as determined in accordance with the requirements of ASTM D 698 have acceptable moisture content.
 - (2) Each layer of non-structural fill compacted to at least 90 percent of the maximum dry density as determined in accordance with the requirements of ASTM D 698 have achieved acceptable compaction.
2. Inspections:
- a. Report shop fabrication errors and/or the deformation of manholes/handholes caused by improper handling and/or transportation that prevent the proper assembly and fitting of parts to the Program/Project Manager.
 - 1) Obtain approval of the method of correction from the Program/Project Manager, and correct the errors as approved at no increase in Contract Price.
 - b. The Program/Project Manager will inspect the underground conduit systems installation as the work progresses.
 - 1) Prior to final approval, the electrical structures will be thoroughly inspected for conformance with the Contract Documents.
 - 2) Defects in materials or workmanship discovered will be further investigated.
 - c. Each of the following must be approved by the Program/Project Manager prior to the Contractor proceeding to the next phase of the installation:



- 1) Trench bed.
 - 2) Lower sand bed.
 - 3) Lower concrete protection slab, where indicated or required.
 - 4) Upper sand bed for conduits.
 - 5) Each layer of conduits.
 - 6) Soil backfill.
 - 7) Warning Tape.
 - 8) Soil backfill.
- d. Failure to comply with any of the above indicated sequential inspection requirements is just cause for the Program/Project Manager to request removal of the work and reinstallation in accordance with this Section.
- B. Non-Conforming Work
1. All unacceptable values will be reported immediately.
 2. Correct all deficiencies found in work of this Contract, and separately report deficiencies in work of items of other contracts.
 3. Items requiring correction will be retested.
 4. Correct or have corrected any remaining deficiencies and have the corrections retested until the work is acceptable.

3.06 ADJUSTING

- A. Where required, make final adjustment of the manhole and handhole frames to the proper elevation using grade rings.

3.07 CLEANING

- A. Conduits:
1. Verify that existing ducts proposed for use under this Contract are clear and open.
 2. As each section of a duct bank line is completed from manhole to manhole, from manhole to building or structure, and/or from handhole to handhole, clean each conduit as follows:
 - a. Mandrel the conduit in ductbanks after the ductbanks have been encased in concrete, but before they have been backfilled.
 - b. Draw a testing mandrel not less than 12 inches long and having a diameter 1/4 inch less than the size of the conduit through each conduit.
 - 1) Use mandrels having a leather or rubber gasket slightly larger than the conduit hole.
 - c. After drawing the mandrel through the conduit, draw a brush with stiff bristles and having the diameter of the duct bank through the conduit until it is clear of particles of earth, sand, and/or gravel.
 - d. Install conduit plugs immediately after brushing the conduit.



- e. Immediately prior to pulling cable, swab out the conduits/ducts, and clean the interiors of base cans, handholes, pull boxes, and similar structures.
 - 1) Once the base cans, manhole, pull boxes, and similar structures have been cleaned and swabbed, keep the accessible points of entry to the duct/conduit system closed except when installing cables.
 - 2) Raceway systems left open after the initial cleaning, for any reason must be re-cleaned at no increase in the Contract Price.
 - 3) Keep accessible points closed when not installing cable.
- B. Structures:
 - 1. Prior to acceptance, clean the entire structure to remove all dirt and debris.
- C. Final Cleaning:
 - 1. After all of the Work performed under this Section is completed, remove tools and other equipment so the Site is free and clear of debris, and is in good condition.
- D. Waste Management:
 - 1. Remove excavated materials not required or suitable for backfill or embankments on the Site as determined by the Program/Project Manager, and legally dispose of them offsite.

3.08 PROTECTION

- A. During construction, protect partially completed duct bank lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/20017	N/A	All	First edition.



SECTION 02591

PHOENIX SKY TRAIN SYSTEM GROUNDING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the Phoenix Sky Train grounding system for buildings or structures as indicated on the Contract Drawings and attachments to this Section.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ETL: Electrical Testing Laboratory.
 - 2. NRTL: Nationally recognized testing laboratories.
 - 3. UFER: A concrete-encased electrode.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Concrete-Encased Electrode: An electrode encased by at least 50mm (2 inches) of concrete, located horizontally near the bottom or vertically, within that portion of a concrete foundation or footing that is in direct contact with the earth, consisting of at least 6.0m (20 feet) of one or more bare or zinc galvanized or electrically conductive coated steel reinforcing bars or rods of not less than 13mm (1/2 inch) in diameter, or consisting of at least 6.0m (20 feet) of bare copper conductor not smaller than 4/0 AWG.
- C. Reference Standards:
 - 1. American Public Transportation Association (APTA):
 - a. APTA SS-E-005-98 - Standard for Grounding and Bonding.
 - 2. American Public Works Association (APWA):
 - a. APWA PB.APWM - APWA Public Works Management Practices Manual.
 - 3. ASTM International (ASTM):
 - a. ASTM B 1 - Standard Specification for Hard-Drawn Copper Wire.
 - b. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.



4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
5. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
6. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System Part 1: Normal Measurements.
 - b. ANSI/IEEE 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
7. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
8. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - b. UL 467 - Standard for Grounding and Bonding Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate installation of Phoenix Sky Train grounding system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies that require bonding to the Phoenix Sky Train grounding system components, and building finishes.

B. Sequencing:

1. Portions of the PHX Sky Train grounding system's uppermost down conductor will be left incomplete until the future completion of the uppermost portion of the buildings or structures.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Conductors.



- 2) Exo-thermic welded connectors.
 - 3) Ground rods.
 - 4) Warning tape.
 - b. Shop Drawings:
 - 1) Phoenix Sky Train grounding system.
 - c. Certificates:
 - 1) Evidence that the products proposed for the system meet the testing agency quality verification requirements.
 - d. Qualification Statements:
 - 1) Phoenix Sky Train grounding system installer's qualifications.
- B. Closeout Submittals:
 - 1. Submit the following to the Program/ Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record documentation:
 - 1) As-built Record Drawings.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Phoenix Sky Train Grounding System Installer's Qualifications:



- a. Employ a grounding system installer, experienced installing grounding systems similar in type and scope to that required by this Contract, to install the Work of this Section.
 - 1) Employ an installation firm having a minimum of 3 years documented experience.
 - 2) The grounding system installer must employ skilled, licensed electricians to supervise the Work of the Section.
 - b. Submit information verifying the grounding system installer's and licensed electrician's qualifications to the Program/Project Manager for approval.
- C. Certifications:
- 1. Electrical Component, Device, and Accessory Certification:
 - a. Provide products that are listed and labeled by nationally recognized testing laboratories (NRTL), such as Underwriters Laboratory, Inc.; approved by FM Approvals LLC; or certified as meeting the standards of Underwriters Laboratory, Inc. by the Electrical Testing Laboratory (ETL), for the location the products are installed in and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories (NRTL) are not available or unless standards do not exist for the products.
 - 1) Provide products with their intended use or classification marked on the products or on a separate listing card.
 - 2) Submit evidence that the products proposed for the system meet the testing agency quality verification requirements, including agency listing and labeling requirements, to the Program/Project Manager with the Product Data for approval.
 - a) Such evidence may consist of either a printed mark on the Product Data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

PART 2 PRODUCTS

2.01 PHX SKY TRAIN GROUNDING SYSTEM

- A. Description:
 - 1. Provide a ground grid system consisting of copper wires, and ground rods, or concrete-encased grounding electrodes (UFERs), of the configuration indicated on the Contract Drawings to minimize station potential gradient irregularities and drain leakage and fault currents to earth.
 - 2. Regulatory Requirements:



- a. Phoenix Building Construction Code:
 - 1) Within buildings, perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - b. Other Codes:
 - 1) Perform the Work of this Section in accordance with the requirements specified in applicable state, local, and national governing codes and regulatory requirements.
- B. Performance:
- 1. Provide a Phoenix Sky Train grounding system having a resistance not greater than 5 Ohms, unless otherwise indicated in the Contract Documents.
- C. Design Criteria:
- 1. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.
 - a. Measure the resistances of systems requiring separate ground resistances separately before bonding below grade.
 - 2. Only provide UL-approved materials listed for grounding systems.
 - 3. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.
 - 4. Conceal the following conductors.
 - a. System conductors.
 - b. Down conductors.
 - c. Interior conductors.
 - d. Conductors normally within view from exterior locations at grade that are within 200 feet of buildings, platforms, and walkways.
 - 5. Product Data:
 - a. Submit Product Data for the materials and products used to perform the Work of this Section.
 - 6. Shop Drawings:
 - a. Prepare Shop Drawings of the proposed PHX Sky Train grounding system.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- D. Materials:
- 1. Conductors:
 - a. Bare Ground Wire:
 - 1) For Number 6 or larger bare ground wire sizes, provide soft drawn copper, Class A or Class B, stranded wire meeting the requirements of ASTM B 8.



- 2) For Number 8 or smaller bare ground wire sizes, provide soft drawn solid copper wire meeting the requirements of ASTM B 1.
2. Exo-Thermic Welded Connectors:
 - a. Provide molds, thermite packages, and other material for exo-thermic welds that are full-rated to carry 100 percent of the cable rating, and which are letter-coded exo-thermic welded type.
 - 1) Provide the exothermic welding materials from a single manufacturer throughout the Project.
 - b. Provide the items necessary for connecting cable to ground-rods.
 - c. Manufacturers:
 - 1) Erico® International Corporation, Cadweld®, www.erico.com.
 - 2) Approved equal.
3. Ground Rods:
 - a. Provide copper-clad steel ground rods conforming to the requirements specified in UL 467.
 - 1) Diameter: 3/4 inch.
 - 2) Length: 10 feet.

2.02 ACCESSORIES

- A. Warning Tape:
 1. Provide 4-mil thick, minimum, polyethylene plastic warning tape over coated with printed graphics that read, "CAUTION-BURIED ELECTRIC LINE".
 2. Provide red colored tape in accordance with the APWA Uniform Color Code as described in the APWA Public Works Management Practices Manual.
 3. Manufacturers:
 - a. Brady Worldwide, Inc., No. 11296, www.bradyid.com.
 - b. Seton Identification Products, www.seton.com.
 - c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLERS

- A. Install the Work of this Section only under the supervision of licensed electricians.

3.02 EXAMINATION

- A. Verification of Conditions:
 1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
 - a. Due to the small scale of the information on the Contract Drawings, it is not possible to indicate all offsets, fittings, and apparatus required or



the minor structural obstructions that may be encountered during the Work.

3.03 INSTALLATION

- A. Install grounding components and systems in accordance with the requirements specified in UL 467, IEEE 81, and IEEE 142.
- B. System Grounding for Elevated Guideway:
 - 1. Ground Rods:
 - a. Unless otherwise indicated, drive ground rods into the ground until the tops of the rods are approximately 6 inches below finished grade.
 - b. Space ground rods as evenly as possible, at least 6 feet apart, and so conductors will be connected below grade.
 - 2. Conductors:
 - a. Provide 4/0 bare ground wire.
 - b. Provide down conductors in all vertical pre-cast vertical columns.
 - 1) Install conductors in direct paths from the top of the columns to the ground connections.
 - c. Using suitable fasteners, securely attach exposed ground wires to structural supports at not more than 2-foot intervals.
 - d. Bends in ground wires greater than 45 degrees are unacceptable.
 - 3. Cable Connections:
 - a. Use approved exothermic-welded connections for conductor splices and connections between conductors and other components.
 - b. Where practical, interconnect ground loop conductors for adjacent columns using approved connection methods.
 - 4. Grounding Rings:
 - a. Install grounding rings using 4/0 bare copper cable with ground rods spaced at 25-foot intervals, minimum, using exothermic weld connecting means as indicated on the drawings attached to the end of this Section.
 - 5. Concrete-Encased Electrodes:
 - a. Where multiple concrete-encased electrodes are present at a building or structure, it is permissible to bond only one into the grounding electrode system.
 - 6. Interface with Other Work:
 - a. At the uppermost end of the completed portions of pre-cast vertical columns and the guideway deck, provide 6 feet of excess down conductor in the form of accessible and usable tails or stubs for future extension of the down conductor to the future system grounding components that will be installed on the uppermost portion of future construction as shown in details GND-9, GND-10, GND-15, GND-16, attached to the end of this Section.
- C. System Grounding for On-Graded Guideway:



1. Ground Rods:
 - a. Drive ground rods into the ground until the tops of the rods are approximately 6 inches below finished grade.
 - b. If multiple ground rods are needed to meet the minimum resistance of 5 Ohms, space ground rods as evenly as possible, at least 6 feet apart, and so conductors will be connected below grade.
2. Conductors:
 - a. Provide 4/0 bare ground wire.
 - b. Install down conductors in the guideway in accordance with detail GND-14 attached to the end of this Section.
 - 1) Install conductors in direct paths from the top of the guideway deck to the ground connections.
 - 2) Space the grounding conductors so they are no more than 100 feet apart.
 - c. Using suitable fasteners, securely attach exposed ground wires to structural supports at not more than 2-foot intervals, where applicable.
 - d. Bends in ground wires greater than 45 degrees are unacceptable.
3. Cable Connections:
 - a. Use approved exothermic-welded connections for conductor splices and connections between conductors and other components.
 - b. Where practical, interconnect ground loop conductors for adjacent columns using approved connection methods.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when the PHX Sky Train grounding system is being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the erection of structural steel.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Resistance Test:
 - a. Test Procedure:



- 1) The ground-resistance measurements of each ground rod will be taken.
 - a) The resistance to ground will be measured in accordance with the fall-of-potential method specified in IEEE 81 and IEEE 142.
 - b) Ground-resistance measurements will be made in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds.
 - 2) Test reports will be prepared that indicate the location of the ground rod, the grounding system, and the resistance and soil conditions at the time the test was performed.
 - b. Acceptance Criteria:
 - 1) The grounding system must have a resistance not greater than 5 Ohms.
 - 2) Do not energize any part of the electrical distribution system prior to the resistance testing of that system's ground rods and grounding system, and submission of the test results to the Program/Project Manager and their approval.
 3. Inspections:
 - a. Prepare and submit as-built Record Drawings of the Phoenix Sky Train grounding system as installed to the Program/Project Manager for approval.
- B. Non-Conforming Work
1. Where the specified ground resistance cannot be met with the number of ground rods indicated in the Contract Documents, install and connect additional ground rods, longer ground rods, or deep driven sectional rods until the specified resistance is obtained, except that not more than 3 additional ground rods are permitted at any one installation.

3.05 PROTECTION

- A. Provide protection for the down conductor tails or stubs provided for the future completion of the uppermost portion of structures so the down conductors will be accessible and usable at that future time.

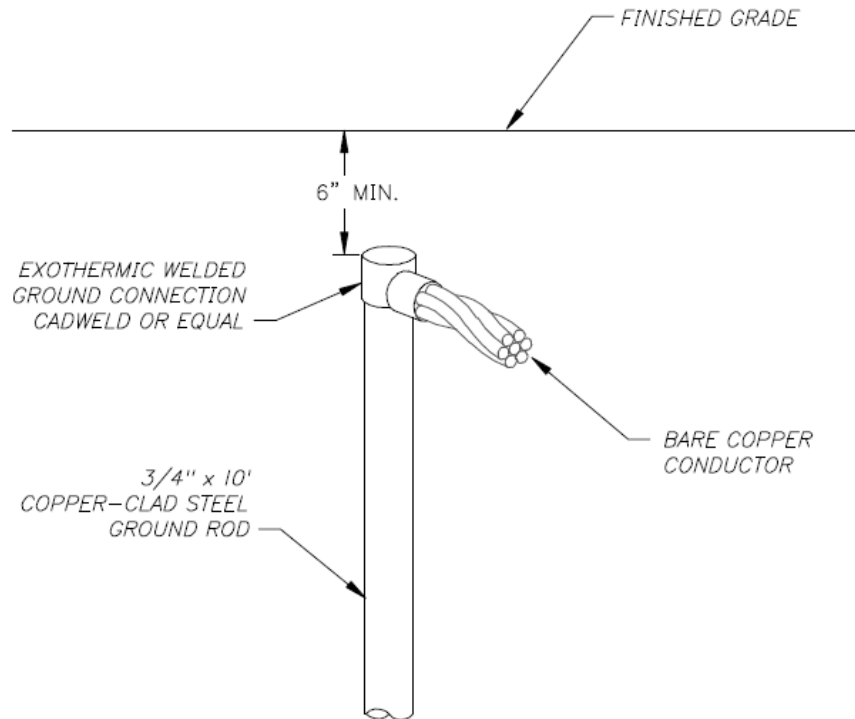
3.06 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
1. GND-1 Automated Train Stage One Design – Cable to Ground Rod Connection.
 2. GND-2 Automated Train Stage One Design – Grounding Detail.
 3. GND-3 Automated Train Stage One Design – Grounding Detail.
 4. GND-4 Automated Train Stage One Design – Grounding Cable to Ground Rod Connection.



5. GND-5 Automated Train Stage One Design – Grounding Detail.
6. GND-6 Automated Train Stage One Design – Grounding Detail.
7. GND-7 Automated Train Stage One Design – Grounding Detail.
8. GND-8 Automated Train Stage One Design – Ground Grid Cable Trench.
9. GND-9 Automated Train Stage One Design - Drilled Shaft Section – Side View.
10. GND-10 Automated Train Stage One Design – Drilled Shaft Section – Side View.
11. GND-11 Automated Train Stage One Design – Drilled Shaft Section – Top View.
12. GND-12 Automated Train Stage One Design – Drilled Shaft Section – Top View.
13. GND-13 Automated Train Stage One Design – Drilled Shaft Section – Top View.
14. GND-14 Automated Train Stage One Design – On-Grade Guideway – Section View.
15. GND-15 Automated Train Stage One Design – Elevated Guideway – Section View.
16. GND-16 Automated Train Stage One Design – Elevated Guideway – Section View.

END OF SECTION



CABLE TO GROUND ROD CONNECTION
NTS

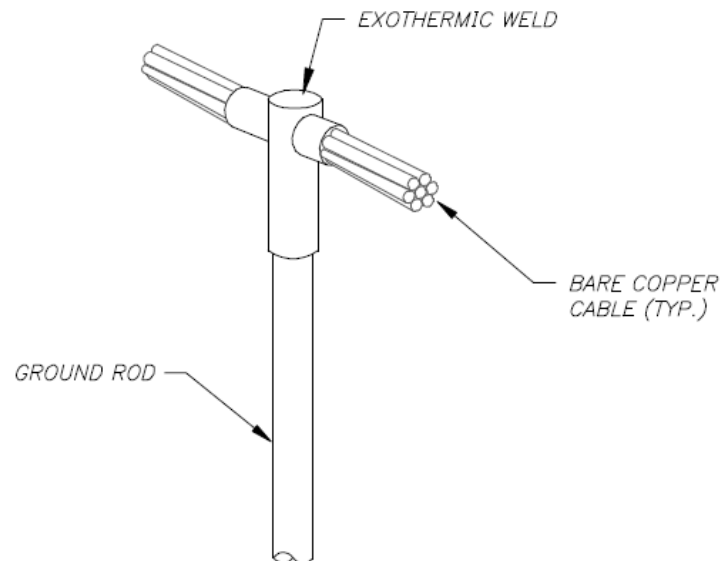


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AUTOMATED TRAIN STAGE ONE DESIGN
CABLE TO GROUND ROD CONNECTION

GND-1

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID THROUGH CABLE TO TOP OF GROUND ROD

NTS

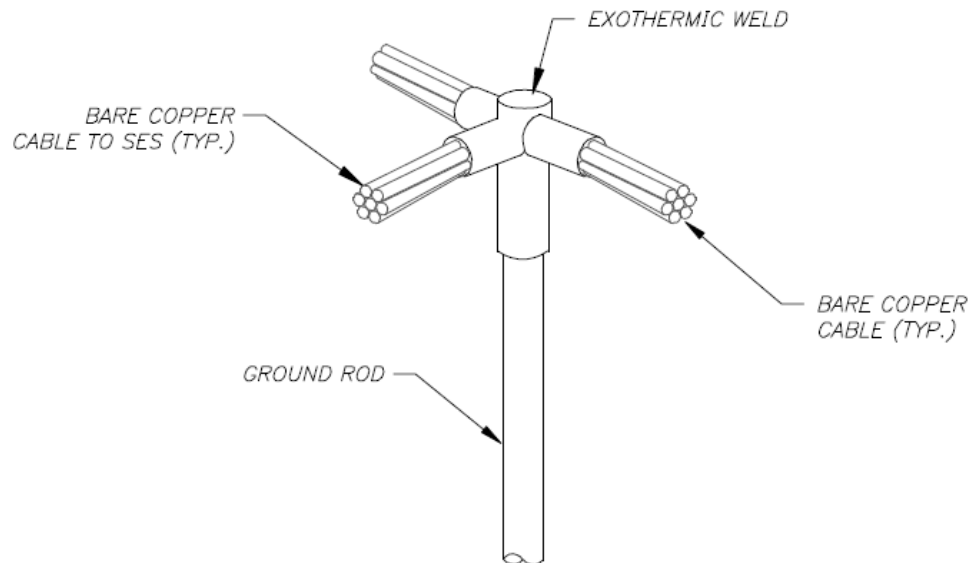


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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING DETAIL

GND-2

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID TEE OF HORIZONTAL RUN
AND TAP CABLES TOP OF GROUND ROD

NTS

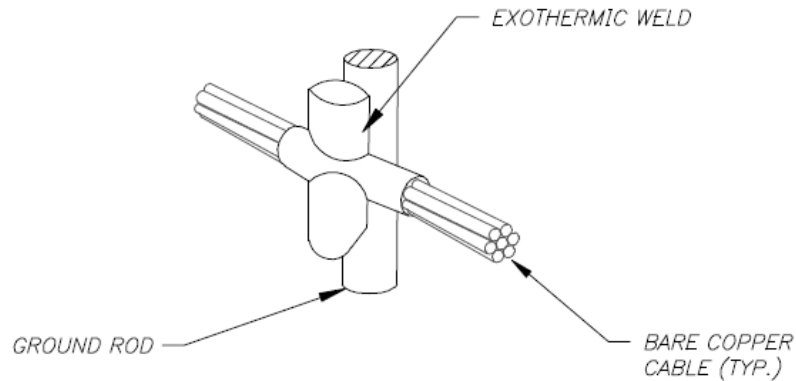


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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING DETAIL

GND-3

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID THROUGH CABLE TO SIDE OF GROUND ROD
NTS

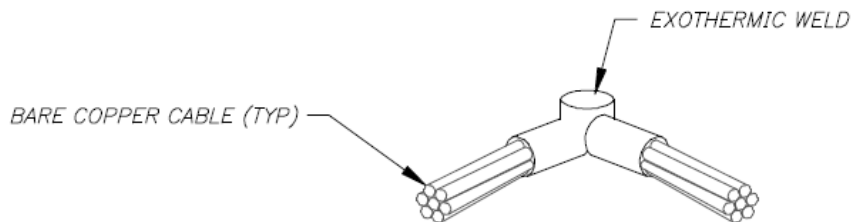


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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING CABLE TO GROUND ROD CONNECTION

GND-4

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID "L" OF HORIZONTAL RUN AND TAP CABLES
NTS

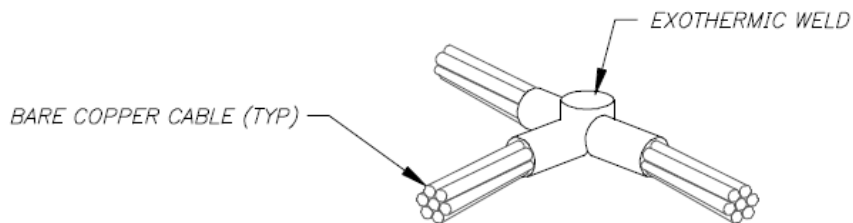


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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING DETAIL

GND-5

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID TEE OF HORIZONTAL RUN AND TAP CABLES

NTS

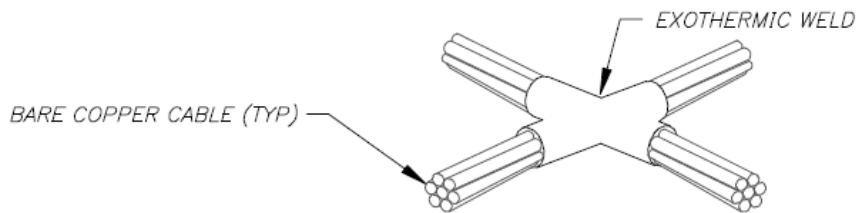


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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING DETAIL

GND-6

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID CROSS OF HORIZONTAL
CABLES, TAP CABLE CUT

NTS

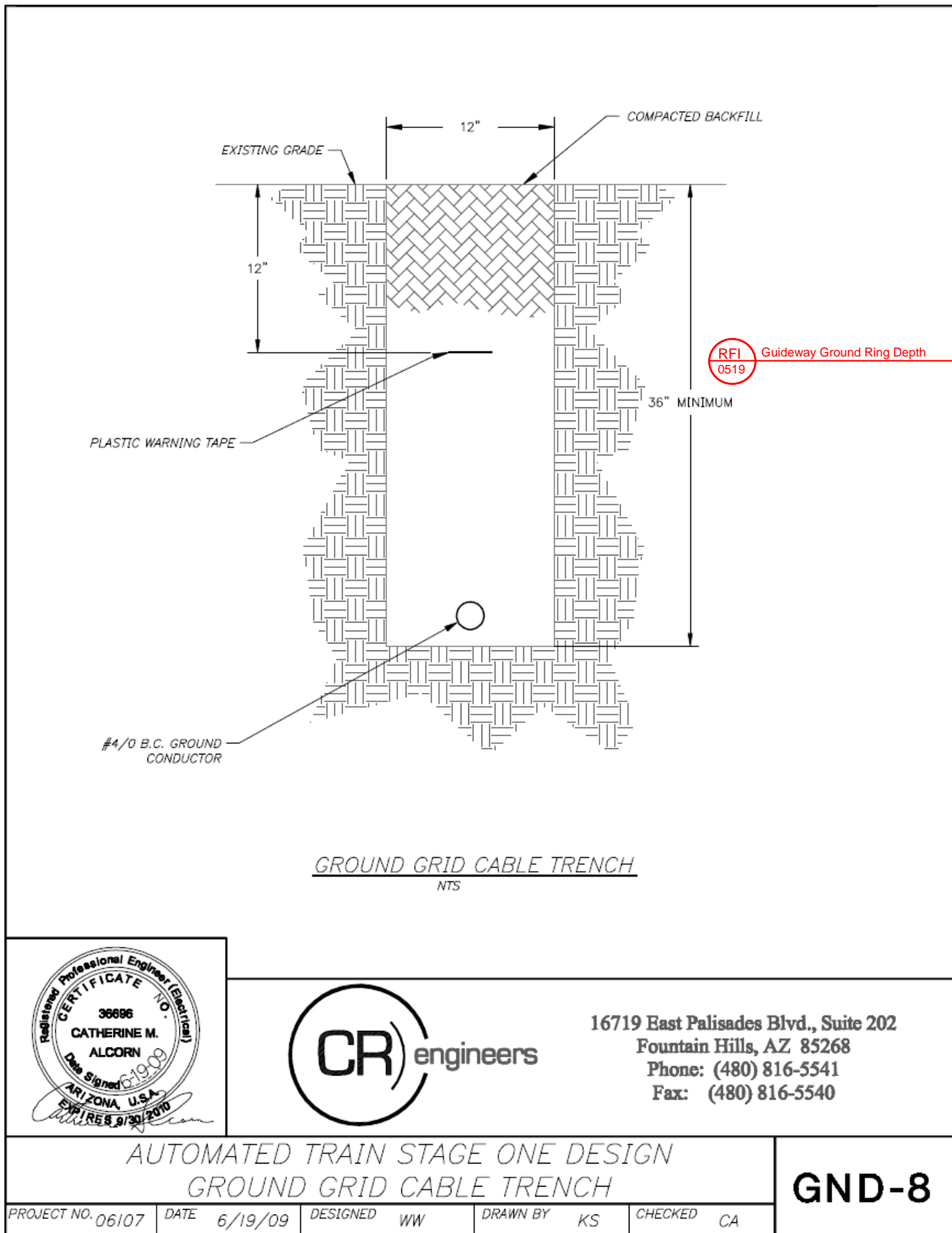


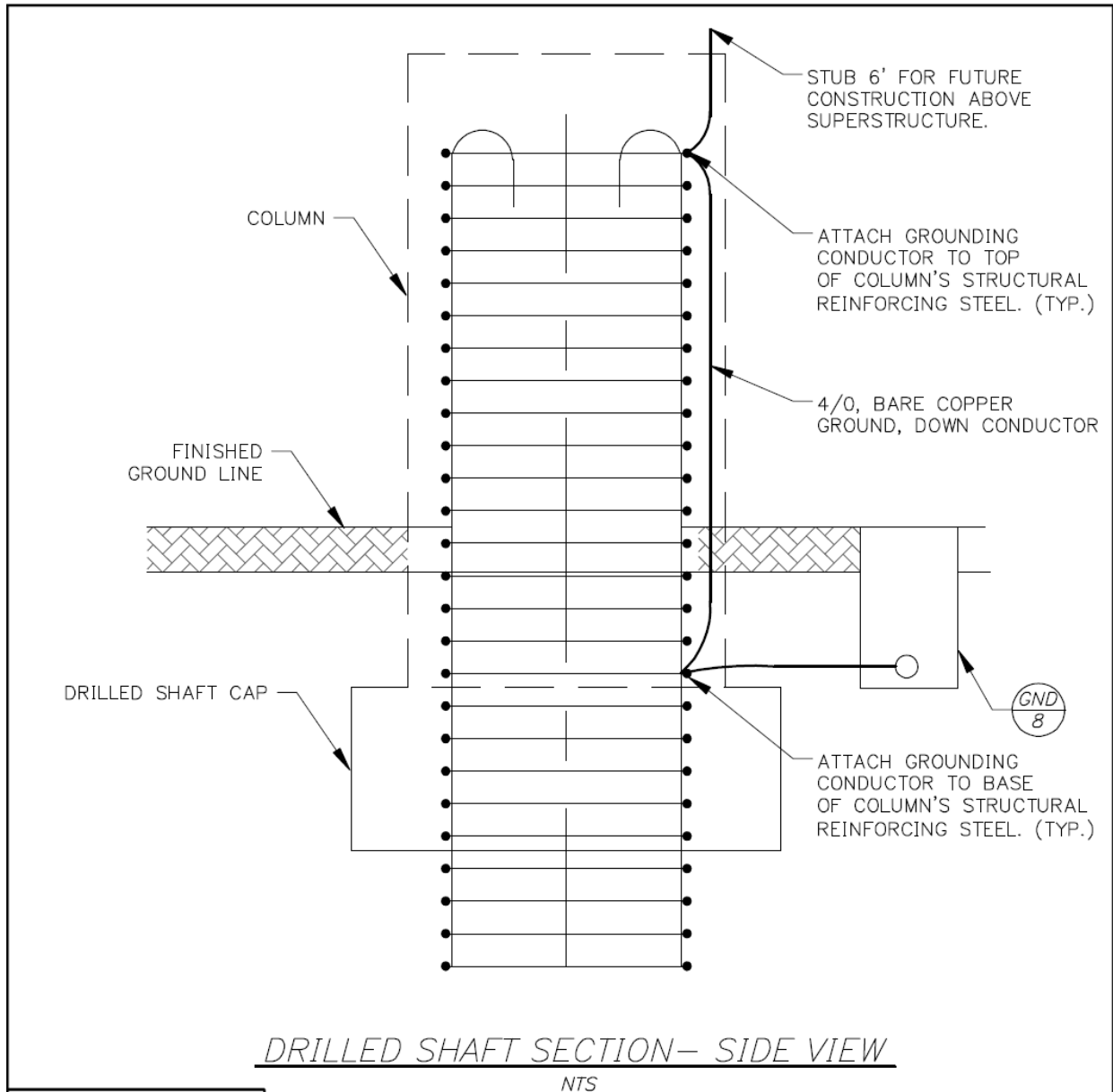
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AUTOMATED TRAIN STAGE ONE DESIGN
GROUNDING DETAIL

GND-7

PROJECT NO. 06107	DATE 6/19/09	DESIGNED WW	DRAWN BY KS	CHECKED CA
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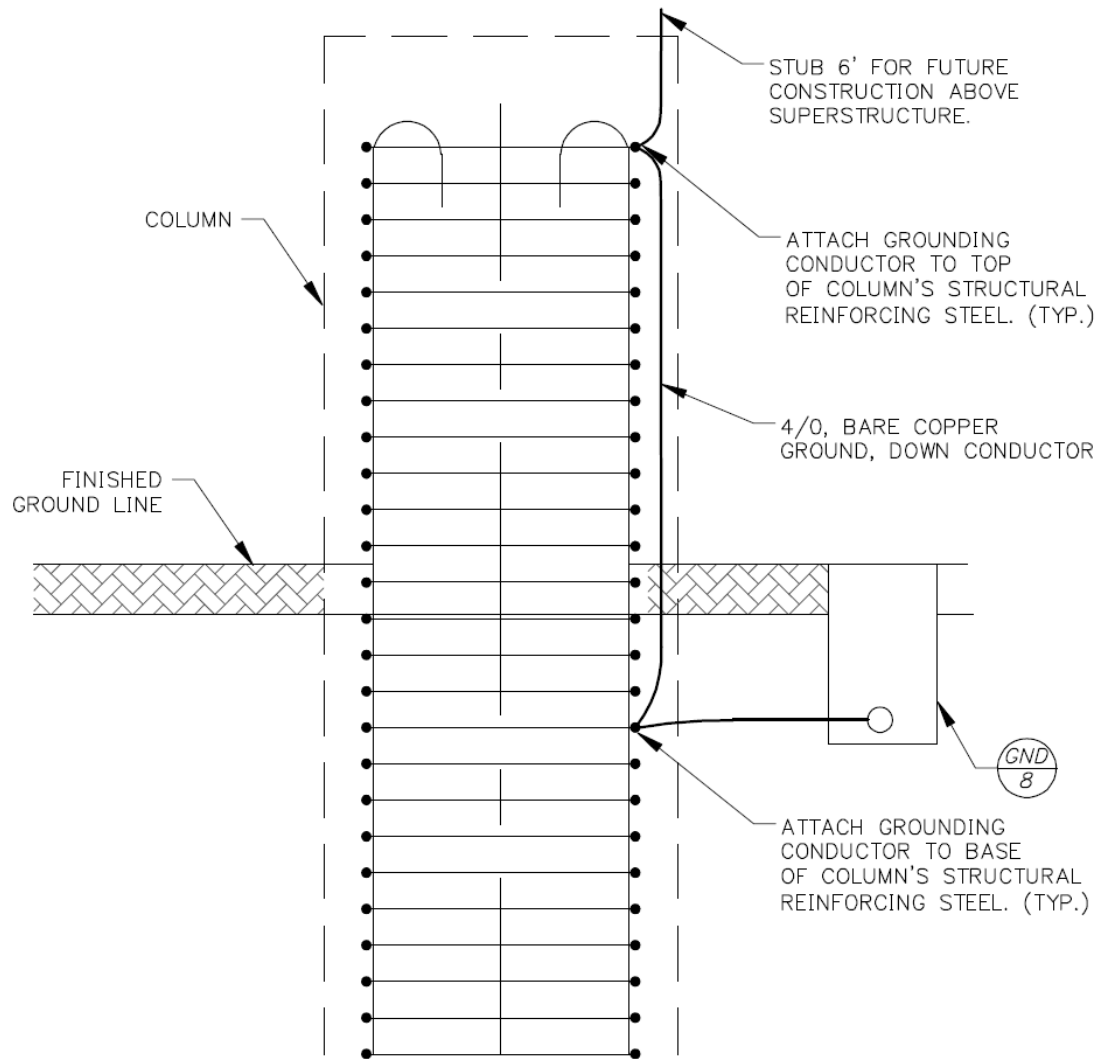


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AUTOMATED TRAIN STAGE ONE DESIGN
DRILLED SHAFT SECTION- SIDE VIEW

GND-9

PROJECT NO. 06107	DATE 1/13/10	DESIGNED WW	DRAWN BY RV	CHECKED CA
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DRILLED SHAFT SECTION- SIDE VIEW

NTS

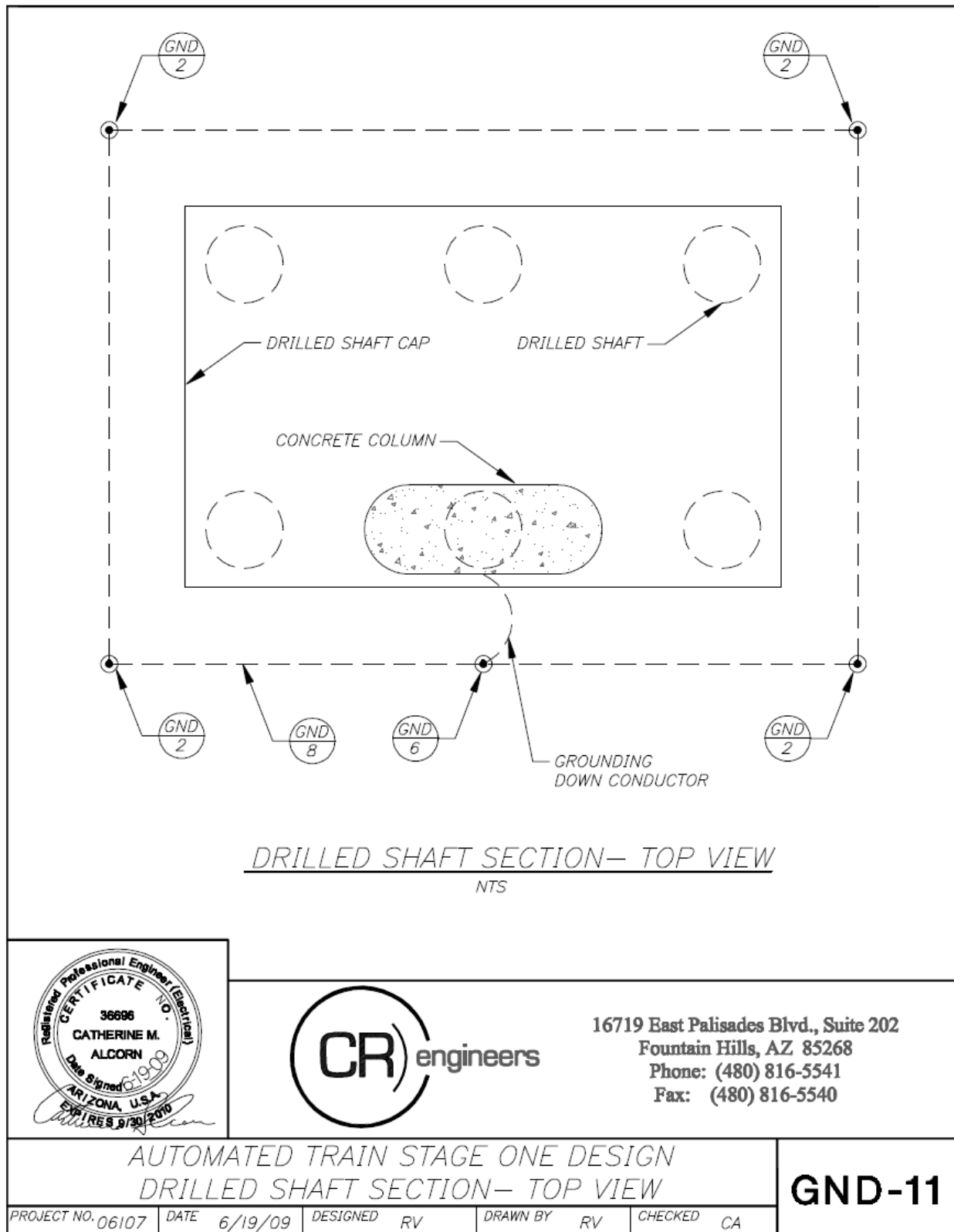


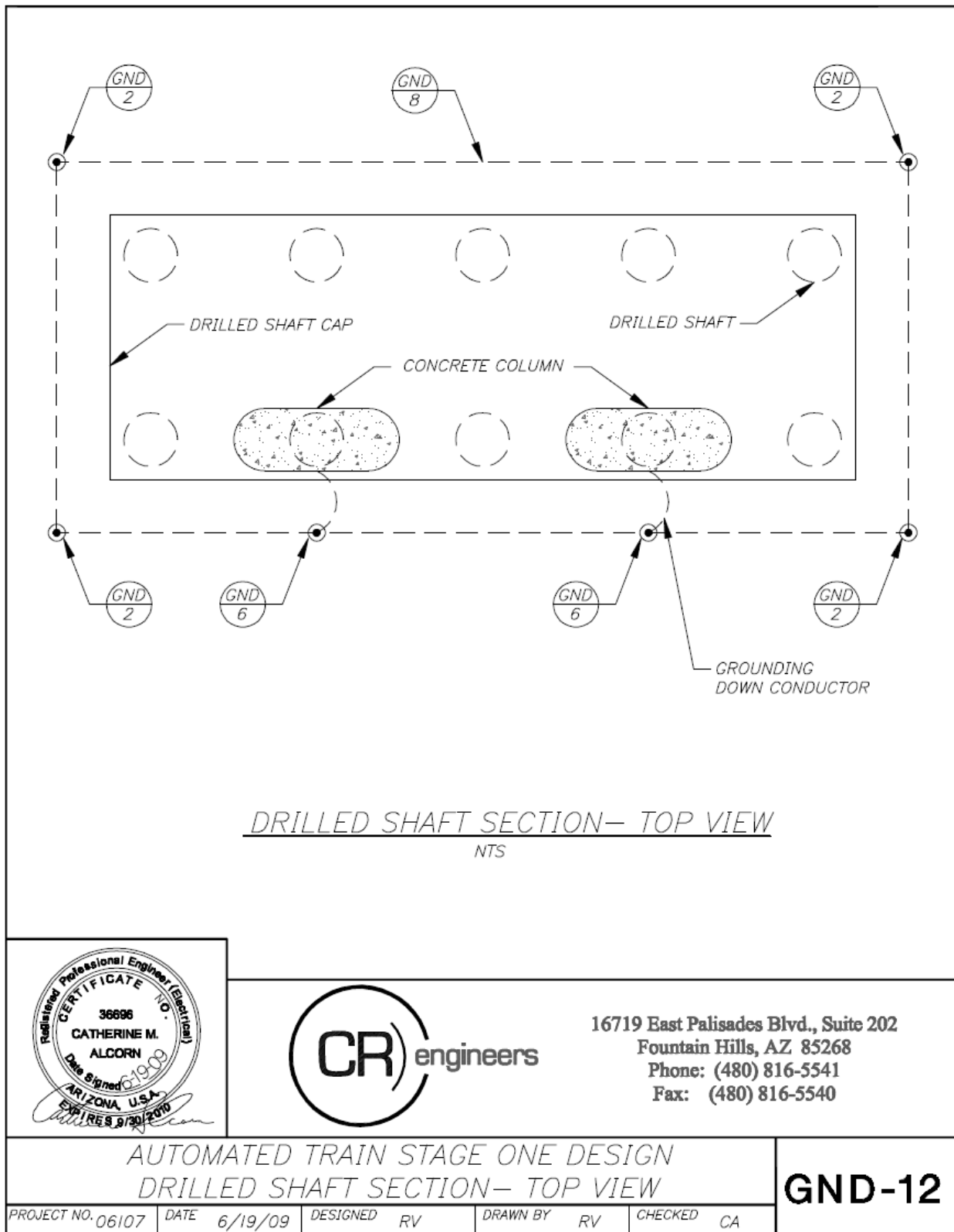
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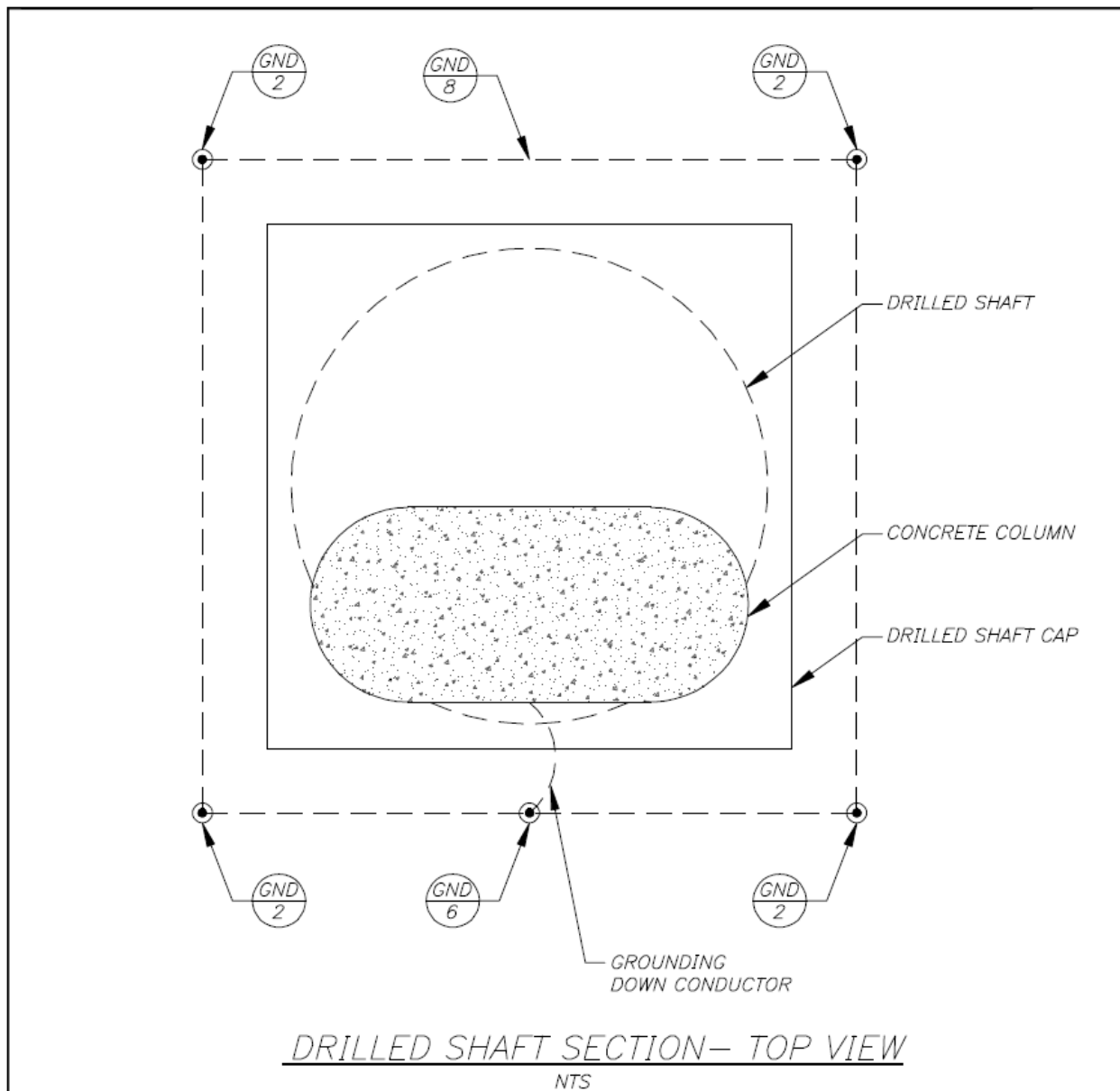
*AUTOMATED TRAIN STAGE ONE DESIGN
DRILLED SHAFT SECTION- SIDE VIEW*

GND-10

PROJECT NO. 06107	DATE 1/13/10	DESIGNED WW	DRAWN BY RV	CHECKED CA
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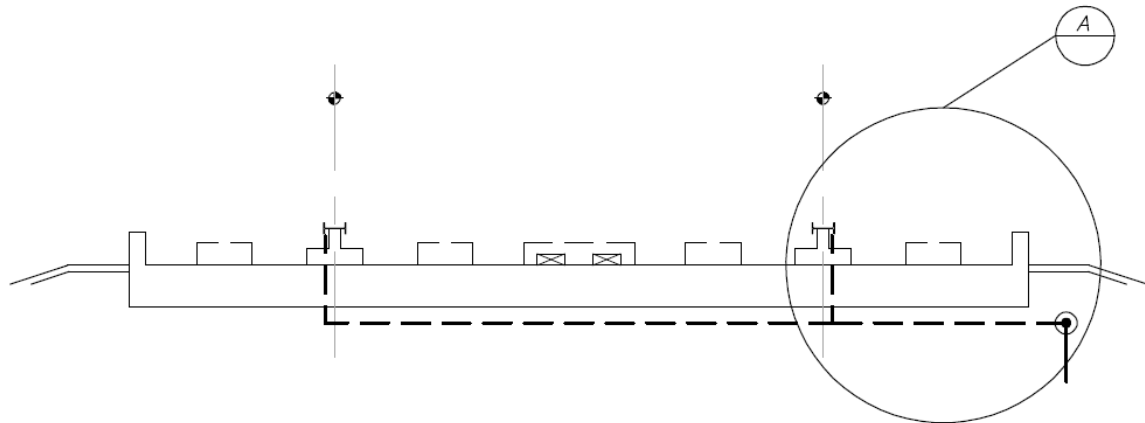


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AUTOMATED TRAIN STAGE ONE DESIGN
DRILLED SHAFT SECTION- TOP VIEW

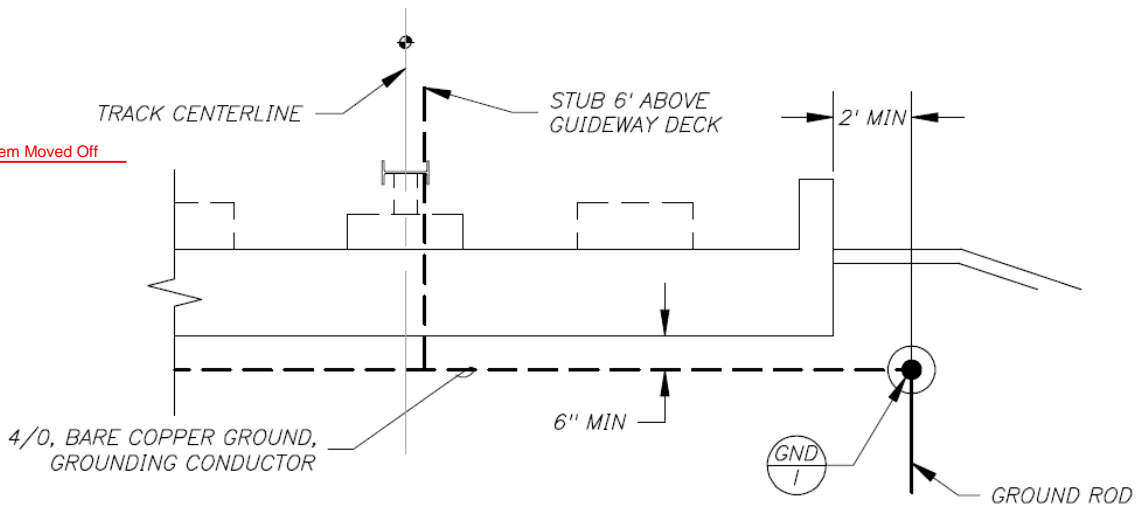
GND-13

PROJECT NO. 06107	DATE 6/19/09	DESIGNED RV	DRAWN BY RV	CHECKED CA
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ON GRADE GUIDEWAY (TYP.) – SECTION VIEW

NTS



SECTION DETAIL

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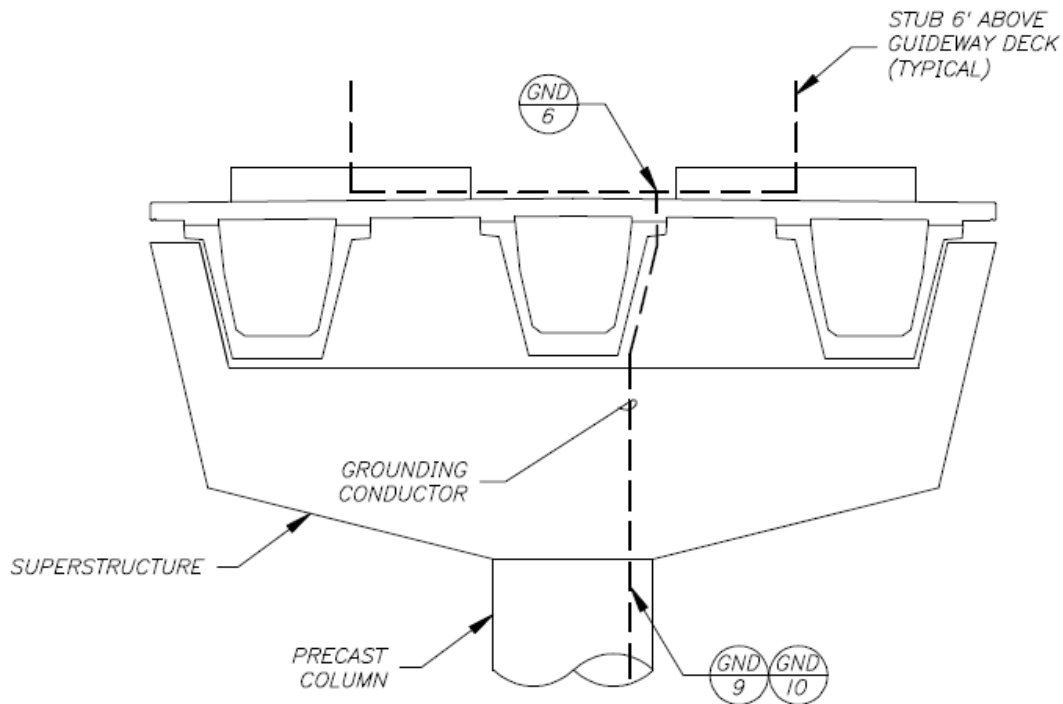


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AUTOMATED TRAIN STAGE ONE DESIGN
ON-GRADE GUIDEWAY – SECTION VIEW

GND-14

PROJECT NO. 06107	DATE 1/13/10	DESIGNED RV	DRAWN BY RV	CHECKED CA
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ELEVATED GUIDEWAY (TYP.) – SECTION VIEW
NTS

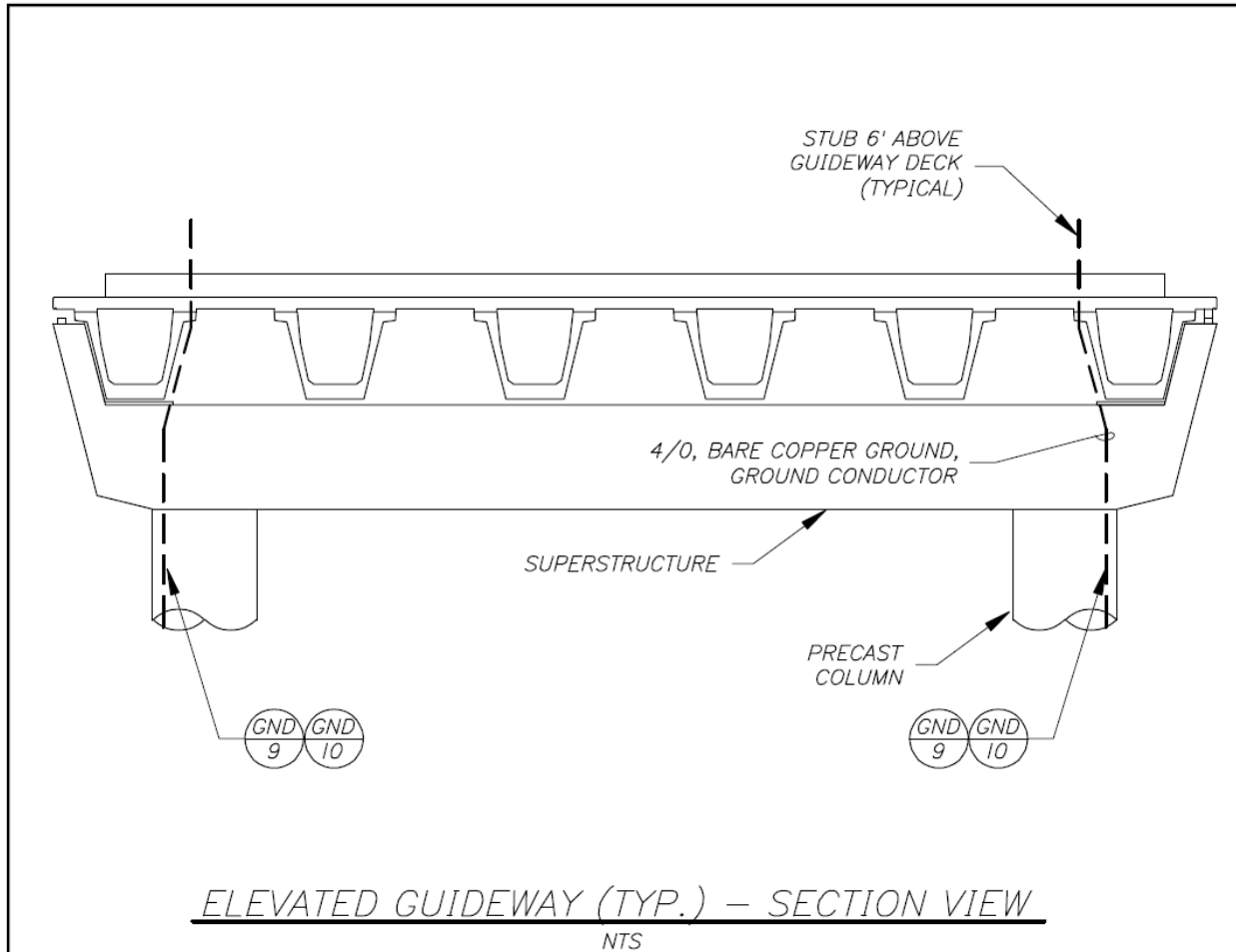


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AUTOMATED TRAIN STAGE ONE DESIGN
ELEVATED GUIDEWAY – SECTION VIEW

GND-15

PROJECT NO. 06107	DATE 11/23/09	DESIGNED RV	DRAWN BY RV	CHECKED CA
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NOTE:
WHERE THERE IS A SINGLE GUIDEWAY RUNNING
ALONG A STRADDLED TYPE GIRDER, ONLY ONE (1)
4/0 BARE COPPER GROUND, DOWN CONDUCTOR,
IS REQUIRED. IT IS TO BE LOCATED ON THE
COLUMN NEAREST TO THE GUIDEWAY TRACK ITSELF
TO PROVIDE TO CLEAREST PATHWAY TO GROUND
AS POSSIBLE.



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*AUTOMATED TRAIN STAGE ONE DESIGN
ELEVATED GUIDEWAY – SECTION VIEW*

GND-16

PROJECT NO. 06107	DATE 1/13/10	DESIGNED RV	DRAWN BY RV	CHECKED CA
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Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 02630

STORM DRAINAGE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing storm drainage and irrigation piping and structures at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01555 - Traffic Control.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 02316 - Trenching and Backfilling.
 - 6. Section 02445 - Boring or Jacking Conduits.
 - 7. Section 02721 - Aggregate Base Course.
 - 8. Section 03200 - Concrete Reinforcement.
 - 9. Section 03300 – Cast-In-Place Concrete.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CSP: Corrugated Steel Pipe.
 - 2. DIP: Ductile Iron Pipe.
 - 3. HDB: Hydrostatic Design Basis.
 - 4. HDPE: High Density Polyethylene.
 - 5. PS: Pipe Stiffness.
 - 6. RCP: Reinforced Concrete Pipe.
 - 7. RSC: Ring Stiffness Constant.
- B. Definitions:
 - 1. Annular: Circumferential.
 - 2. Bedding: Material to be placed in pipe trenches filling the volume from the bottom of the trench to 1 foot above the top of the buried pipe or conduit, excluding the pipe and its interior.
 - 3. Cast-In-Place Concrete Pipe (CIPP): Conduit constructed from Portland cement concrete cast monolithically in a properly prepared trench using equipment specifically designed for the purpose.
 - 4. Downgrade Pipe: Pipe which is to be used under loads less than that for which they have been designed.
 - 5. Duckbill Valve: A check valve in which flow proceeds through a soft tube that protrudes into the downstream side; back-pressure collapses this tube, cutting off flow.



6. Longitudinal Crack: A crack in a constructed cast-in-place concrete pipe having a general direction 30 degrees or less from the direction of the pipe alignment.
7. Profile Wall: A pipe wall construction that presents an essentially smooth surface in the waterway but includes ribs or other shapes, which can be either solid or hollow, that help brace the pipe against diametrical deformation.
8. Ring Stiffness Constant: The value obtained by dividing the parallel plate load in pounds per foot of pipe by the resulting deflection in percent at 3 percent deflection.
9. Springline or Springing Line: In a transverse cross section of pipe, the line of maximum horizontal dimension.

C. Reference Standards:

1. American Association of State highway and Transportation Officials (AASHTO):
 - a. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
 - b. AASHTO M 190 - Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 - c. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe.
 - d. AASHTO M 274 - Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe.
 - e. AASHTO M 294 – Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter.
 - f. AASHTO T 99 – Standard Method of Test for Moisture-Density of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 - g. AASHTO T 191 - Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
2. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction.
3. ASTM International (ASTM):
 - a. ASTM A 929/A 929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.
 - b. ASTM C 14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
 - c. ASTM C 33 - Standard Specification for Concrete Aggregates.
 - d. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - e. ASTM C 150 - Standard Specification for Portland Cement.
 - f. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete.
 - g. ASTM C 361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.



- h. ASTM C 497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
- i. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- j. ASTM C 923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- k. ASTM D 393 - Standard Specification for Chemical-Resistant Resin Mortars.
- l. ASTM D 412 - Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- m. ASTM D 448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
- n. ASTM D 1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- o. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- p. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.
- q. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- r. ASTM D 2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- s. ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- t. ASTM D 2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- u. ASTM D 2922 – Standard Test Method for density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- v. ASTM D 3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- w. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- x. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
- y. ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- z. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- 4. City of Phoenix (COP):
 - a. Phoenix Supplemental Standard Details for Public Works - Construction:
 - 1) Detail No. P1200 Trench Backfill & Surface Replacement.
 - 2) Detail No. P1505 Concrete Pipe Collar.



- 3) Detail No. P1520 Storm Drain Manhole Base 48" & Smaller.
- 4) Detail No. P1560 Storm Drain Manhole Base Transition 51" & Larger.
- 5) Detail No. P1561 Frame and Cover Catch Basin Access.
- 6) Detail No. P1562 Barrier Specification Schedule.
- 7) Detail No. P1563 Storm Sewer Access Barrier.
- 8) Detail No. P1564 Catch Basin Grate Frames.
- 9) Detail No. P1565 Catch Basin Grates.
- 10) Detail No. P1566 Catch Basin Combination Type "J" with Concrete Apron.
- 11) Detail No. P1567 Catch Basin Combination Type "K".
- 12) Detail No. P1568 Catch Basin - Type "L" Curb & Parkway Opening Inlet Details.
- 13) Detail No. P1569-1 Catch Basin Type "M".
- 14) Detail No. P1569-2 Catch Basin - Type "M" Top Modification in Landscape Parkway.
- 15) Detail No. P1570 Catch Basin - Type "N".
- 16) Detail No. P1571 Catch Basin - Type "P" Double Curb Opening for Frontage Road Islands.
- 17) Detail No. P1572 Catch Basin - Type "Q".
- 18) Detail No. P1573 Catch Basin - Type "R".
- 19) Detail No. P1574 Inlet Curb Opening & Pipe Entry Detail.
- 20) Detail No. P1575 Construction Sub-Grade Drain.
- 21) Detail No. P1576 Cast-In-Place Pipe Lateral Pipe Connection.
- 22) Detail No. P1577 Small Storm Drain Lateral Connection of Catch Basin Connector Pipe to Existing Storm Drain Main.
- 23) Detail No. P1578 Large RCP Storm Drain Lateral or Catch Basin Connector Pipe to Existing RCP Storm Drain Main.
- 24) Detail No. P1581 Type M Modified Catch Basin (Offset Opening).
- 25) Detail No. P1583 Type R Modified Catch Basin (with Rear Inlet).
- 26) Detail No. P1584 (with Wing and Offset Opening) Type R Modified Catch Basin.
- b. City of Phoenix Storm Water Policies and Standards.
- c. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
5. International Code Council (ICC):
 - a. ICC International Building Code 2006 (IBC).
6. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Specifications for Public Works Construction.
 - b. MAG Uniform Standard Details for Public Works Construction.
 - 1) Detail No. 501-1 Headwall.
 - 2) Detail No. 501-2 Headwall.



- 3) Detail No. 501-3 Headwall 42" to 84" Pipe.
 - 4) Detail No. 501-4 Headwall Irrigation 18" to 60" Pipe.
 - 5) Detail No. 501-5 Headwall Drop Inlet.
 - 6) Detail No. 502-1 Trash Rack.
 - 7) Detail No. 502-2 Trash Rack.
 - 8) Detail No. 503 Irrigation Standpipe.
 - 9) Detail No. 504 Concrete Block Junction Box.
 - 10) Detail No. 505 Concrete Pipe Collar.
 - 11) Detail No. 506 Irrigation Valve installation.
 - 12) Detail No. 507 Encased Concrete Pipe (for Shallow Installation).
 - 13) Detail No. 510 Corrugated Metal Pipe and Installation.
 - 14) Detail No. 521 Storm Drain Manhole Base (51" or Larger).
 - 15) Detail No. 522 Storm Drain Manhole Shaft.
 - 16) Detail No. 523-1 Pressure Manhole.
 - 17) Detail No. 523-2 Pressure Manhole.
 - 18) Detail No. 524 Storm Drain Lateral Pipe Connections [*Detail not allowed by the City of Phoenix*].
 - 19) Detail No. 530 3"-6" Curb Opening Catch Basin - Type "A".
 - 20) Detail No. 531 3"-6" Curb Opening Catch Basin - Type "B".
 - 21) Detail No. 532 8"-0" Curb Opening Catch Basin - Type "C".
 - 22) Detail No. 533-1 Catch Basin Type 'D'.
 - 23) Detail No. 533-2 Apron for Type 'D' Catch Basin.
 - 24) Detail No. 533-3 Frame and Grate for Type 'D' Catch Basin.
 - 25) Detail No. 534-1 Catch Basin Type 'E'.
 - 26) Detail No. 534-2 Catch Basin Type 'E' (Details).
 - 27) Detail No. 534-3 Catch Basin Type 'E' (Details).
 - 28) Detail No. 534-4 Catch Basin Type 'E' (Details).
 - 29) Detail No. 534-5 Alternate Grate Styles Sump Location.
 - 30) Detail No. 535 Catch Basin Type 'F' (for Use without Curb).
 - 31) Detail No. 536-1 Common Details and Sections for Curb Opening Catch Basins.
 - 32) Detail No. 536-2 Alternate Cover for Curb Opening Catch Basins.
 - 33) Detail No. 537 Catch Basin - Type 'G'.
 - 34) Detail No. 538 Catch Basin - Type 'H'.
 - 35) Detail No. 539 Grates for Catch Basins, Type G and H.
 - 36) Detail No. 540-1 Catch Basin Grates.
 - 37) Detail No. 540-2 Catch Basin Grates.
 - 38) Detail No. 545 End Section-Reinforced Concrete Pipe.
 - 39) Detail No. 550 Spillway Inlet and Outlet.
 - 40) Detail No. 552 Concrete Cut-Off Walls.
 - 41) Detail No. 555 Erosion Protection / Riprap.
7. NSF International (NSF):
- a. ANSI/NSF 61 Drinking Water System Components – Health Effects.



8. Plastic Pipe Institute (PPI):
 - a. PPI Third Party Certification Program.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities by construction operations.
 - a. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from the authorities having jurisdiction.
 - 1) Coordinate street and sidewalk closings and traffic control with the City of Phoenix Street Transportation Department Traffic Operations Division, the City of Phoenix Right-of-Way Management program, and with other appropriate government agencies.
 - 2) Obtain all permits required by the City of Phoenix, and pay necessary fees.
 - 3) Prepare traffic control and walkway plans required by the City of Phoenix Special Traffic Regulations.
 - b. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 1) Ensure safe passage of persons around the area of construction.
2. Coordinate all utility related work during storm drainage work activities with Aviation Facilities and Services at Phoenix Sky Harbor International Airport to avoid tapping into established utilities.
3. Forward all utility information to the Design and Construction Services Division (DCS) of the Phoenix Sky Harbor International Airport.
4. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to schedule shut downs of utilities and services
5. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to disconnect, relocate, and/or provide temporary utility service connections and lines as needed if these have not been previously completed.
 - a. Coordinate all utility related work during construction activities to avoid tapping into established Aviation Facilities and Services utilities at Phoenix Sky Harbor International Airport.
 - b. Forward all utility information to the Design and Construction Services Division (DCS) of the Phoenix Sky Harbor International Airport.

B. Scheduling:

1. Cast-In-Place Concrete Pipe (CIPP):
 - a. Schedule cast-in-place concrete pipe work activities and work schedules to minimize overtime for the Program/Project Manager's staff.



- 1) No schedule requiring overtime by the Program/Project Manager's staff is authorized without the written approval of the Program/Project Manager.
- 2) Prior to starting concrete placement for cast-in-place concrete pipe, submit a written Schedule for Cast-In-Place Concrete Pipe Work Activities to the Program/Project Manager for approval.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Piping and piping specialties.
 - 2) Valves.
 - b. Shop Drawings:
 - 1) Layout drawings for piping and piping specialties.
 - 2) Drawings of the transition manhole base option using a prefabricated transition manhole base with a 48-inch stubbed manhole shaft cast as 1 structure.
 - 3) Pipe specials.
 - 4) Valves.
 - c. Certificates:
 - 1) Cement mill certificates for each load of cement delivered to the concrete pipe fabrication plant.
 - 2) Reinforced concrete pipe manufacturer's certification that calcium chloride or an admixture containing calcium chloride was not used in the pipe concrete mix.
 - 3) Reinforced concrete pipe reinforcing steel manufacturer's mill certificates, or the pipe manufacturer's certification for stockpiled pipe.
 - 4) High Density Polyethylene (HDPE) Pipe Watertight Certification.
 - 5) Certification of reinforced concrete pipe (RCP) and non-reinforced concrete pipe (NRCP) hydrostatic leak tests.
 - d. Delegated Design Submittals:
 - 1) Design mixes for mortar/grout.
 - 2) Equipment proposed to construct cast-in-place concrete pipe.
 - 3) Schedule for Cast-In-Place Concrete Pipe Work Activities.
 - e. Qualification Statements:
 - 1) Qualifications and certifications of the proposed Material Testing Laboratories.
 - 2) Experience record of the operators proposed to construct cast-in-place concrete pipe.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Corrugated Steel Pipe (CSP) Bituminous Coating Test results.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's joint preparation instructions.
 - 2) Manufacturer's recommended pipe repair procedures.
 - 3) Duckbill valve manufacturer's installation recommendations and instructions.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built information for the storm drainage system.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. The Work of this section is subject to approvals before it can be put into service and accepted.
 - a. If the Project impacts water bodies, a Clean Water Act, Section 404 permit will be required by the U.S. Army Corps of Engineers.
 - b. Compliance with the Arizona Pollution Discharge Elimination System (AZDES) general permit for storm water discharges from construction sites is required.
 - c. Compliance with the Federal Endangered Species Act is required.
 - d. Compliance with the national Historic Preservation Act, the City's archaeological policy, the Arizona Antiquities Act, and the State Historic Preservation Act are required.
 - e. Compliance with the City of Phoenix Storm Water Policies and Standards.
- B. Qualifications:
 1. Material Testing Laboratories:
 - a. To perform testing of the materials to be incorporated into the Work, and to control testing and inspections of the Work this Section, employ the services of one or more independent certified material testing laboratories having the following qualifications:
 - 1) Each Material Testing Laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 329 and other standards specified in individual Specification Sections.



- 2) Each Material Testing Laboratory must be capable of performing the reviews, inspections, and testing required of them by this Contract; including but not limited to the following:
 - a) Inspecting, sampling, and testing proposed materials and production as required by the Program/Project Manager for compliance with the Contract Documents.
 - b) Capable of securing production samples of materials at plants or stockpiles during the course of the work, and testing the samples for compliance with the Contract Documents.
 - 3) The Material Testing Laboratory must be approved by the Program/Project Manager, and must also be accepted by the local jurisdictions responsible for building inspection.
- b. The Material Testing Laboratories retained by the Contractor will not be responsible for performing the special inspections required by the ICC International Building Code.
- c. Dismissal and replacement of any of these independent certified Material Testing Laboratories by the Contractor requires written notice to and the approval from the Program/Project Manager.
- d. Submit the qualifications and certifications of the proposed Material Testing Laboratories to the Program/Project Manager for approval.
2. Reinforced Concrete Pipe (RCP) Manufacturer's Qualifications:
 - a. Obtain reinforced concrete pipe from a manufacturer competent to manufacture the type, size, and quality of pipe specified; having satisfactory curing and storage facilities; and having satisfactory financial resources.
3. Valve Manufacturer's Qualifications:
 - a. Obtain valves from a manufacturer having a minimum of 2 years' experience manufacturing the type, size, and quality of valves specified in this Specification Section.
4. Cast-In-Place Concrete Pipe (CIPP) Constructor Qualifications:
 - a. Employ a Subcontractor for constructing cast-in-place concrete pipe (CIPP) who has operators experienced in using the specialized type of equipment required to construct cast-in-place concrete pipe, and who can provide evidence of successful use of this equipment on prior projects.
 - 1) Submit the equipment proposed to construct cast-in-place concrete pipe for this Contract to the Program/Project Manager for approval.
 - 2) Submit the experience record of the operators proposed to construct cast-in-place concrete pipe for this Contract to the Program/Project Manager for approval.

C. Certifications:

1. For each load of cement delivered to the concrete pipe fabrication plant, submit 3 copies of the cement mill certificate indicating the specification,



- type, chemical analysis, and quantity of cement to the Program/Project Manager for information.
2. For stockpiled cement pipe, submit a manufacturer's certification that the type of cement used to manufacture the cement pipes complies with the specified requirements.
 - a. For reinforced concrete pipe, include certification that the cement content of the concrete complies with the specifications for yield per cubic yard of concrete poured.
 3. High Density Polyethylene (HDPE) Pipe Watertight Certification:
 - a. Submit a copy of the certification from an approved independent laboratory certifying that the high-density polyethylene (HDPE) pipe provided complies with the watertight standard stipulated in ASTM D 3212.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
 - a. During transportation and handling of concrete pipes, furnish struts and other protective measures as necessary to limit cracks in the pipes that will render the pipes unacceptable as specified herein.
 - b. Strutting of corrugated metal pipe (CMP) must be approved by the Program/Project Manager.
 - c. Exercise extreme care to prevent damage to the ends of concrete pipe.
 - d. To protect the external spigot end of ductile iron pipes against abrasion and damage during shipping and handling, furnish temporary protective collars on the exterior of each spigot end of each pipe section.
 - 1) Secure the temporary protective collars to the pipe to prevent accidental removal during shipping and normal handling by the Contractor.
 - 2) Do not remove the temporary collars until immediately before the pipe is to be installed or field cut.

B. Storage and Handling Requirements:

1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
 - a. Store and handle high density polyethylene (HDPE) pipe so out-of-roundness is minimized.
 - b. Store high density polyethylene (HDPE) pipe in shaded areas to minimize adverse effects of exposure to warm temperatures and ultraviolet light.



- c. Furnish cloth belt slings or ropes to hoist high density polyethylene (HDPE).
- d. Handle corrugated steel pipe (CSP) so the external coating, spelter coating, and internal lining are not damaged.
2. Protect pipe from impact shocks and free fall during handling.
3. Store rubber gaskets in a cool, dark place until they are installed.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Keep trenches dewatered until pipe joints have been made and concrete cradle and encasement, if any, have cured.
2. Do not lay pipe in water or on bedding containing frost.
3. Do not lay pipe when weather conditions are unsuitable, as determined by the Program/Project Manager, for pipe laying work.
4. Do not place concrete for the cast-in-place concrete pipe (CIPP) when the concrete temperature exceeds 90 degrees Fahrenheit or is less than 50 degrees Fahrenheit, or if the soil adjacent to the trench is below freezing.

B. Existing Conditions:

1. Boring logs shown on the Contract Drawings or included in the Specifications are included for the Contractor's convenience only, and do not constitute a part of the Contract.
 - a. It is not intended to imply that the character of the material is the same as shown on the logs at points other than where each boring was made.
 - b. It is the Contractor's responsibility to satisfy itself regarding the actual soil moisture content, and the amount of rock, gravel, sand, silt, clay, and water, to be encountered during the Work of this Section.
2. Only construct cast-in-place concrete pipe (CIPP) in ground capable of standing unsupported from the bottom of the trench to the top of the pipe without sloughing unless it is demonstrated to the satisfaction of the Program/Project Manager that placed fill will adequately support pipe or the Specifications indicate that cast-in-place concrete pipe is allowable for the application.
3. The Program/Project Manager will furnish alignment and elevation stakes at agreed upon intervals and offset, and cut sheets showing the difference in elevation from the top of the stakes to the flow line of the pipe.
4. Assume the risks attending to the presence or proximity, if any, of overhead or underground public utility and private lines, pipes, conduits and their associated support work, and other structures and property of every kind and description, in or over excavations, or in the vicinity of the work, whether above or below the surface of the ground.



PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Minimum Pipe Size:
 - 1. Main Line: 18 inches.
 - 2. Catch Basin Connector Pipe: 15 inches.
- B. Use only one type and class of pipe in any continuous line of piping between structures, unless otherwise indicated on the Contract Drawings.
 - 1. For permit construction, provide either Class III reinforced concrete pipe (RCP), or high-density polyethylene (HDPE) pipe.
- C. Concrete Pipe:
 - 1. The D-loads specified for the design of concrete pipe are based on the loads to which the pipe will be subjected upon completion of the Project.
 - 2. Provide reinforced concrete pipe of the size, type, and D-load indicated on the Contract Drawings or specified for the item of Work.
 - a. For pipe installed under railroad tracks, provide Class V reinforced concrete pipe.
 - b. For pipe installed in tunnels, provide Class III or stronger reinforced concrete pipe.
- D. Cast-in-place, unreinforced concrete pipe (CIPP):
 - 1. Minimum Diameter: 30 inches.
 - 2. Minimum Allowable Thickness:
 - a. Calculate the minimum thickness of unreinforced concrete pipe in inches by adding the diameter of the pipe in feet to 1 inch; for example, the minimum thickness of a 36 inch diameter pipe, T_{36} , would be calculated as follows:
$$T_{36} = \left(\frac{36 \text{ inches}}{12 \text{ inches/foot}} \right) + 1 \text{ inch} = 4 \text{ inches}$$
 - 3. Do not use cast-in-place, unreinforced concrete pipe (CIPP) within the curb returns of major arterial or collector streets, or within other signalized or potentially signalized intersections.
 - 4. Cast-in-place, unreinforced concrete pipe (CIPP) is not allowed where the soil cannot stand vertically in trenches.
- E. Corrugated Steel Pipe (CSP):
 - 1. Corrugated steel pipe (CSP) not allowed where the soil resistivity readings are below 1500 ohms per cubic centimeter.
- F. High Density Polyethylene (HDPE) Pipe:



1. High density polyethylene (HDPE) pipe may be used for mainline storm drain pipes and catch basin connector pipes 48 inches in diameter or smaller provided the pipe is Type S with watertight joints meeting or exceeding 10.8 psi (25 feet of water head) water pressure test criteria as specified in ASTM D 3212.
 - a. Do not use High Density Polyethylene (HDPE) pipe within 24 lineal feet of an open outfall.
 - 1) Within 24 lineal feet of an open outfall, provide concrete or concrete lined storm drain outfall pipe sections in lieu of HDPE.
2. Hydrostatic Design Basis (HDB):
 - a. Provide high density polyethylene (HDPE) pipe having a Hydrostatic Design Basis (HDB) not less than 1250 psi for water at 73.4 degrees Fahrenheit as determined in accordance with Test Method ASTM D 2837.

G. Manholes:

1. Manholes are required for mainline storm drain pipe size changes, vertical grade breaks, horizontal angle deflections greater than 5 degrees, mainline pipe intersections, and periodic locations for access and maintenance.
 - a. Match the inside top of pipe elevations (pipe crowns) when the mainline pipe size changes.
 - b. If the downstream pipe size is smaller than the upstream pipe's size, match the pipe invert elevations.
2. Maximum Manhole Spacing:
 - a. For manholes less than or equal to 30 inches in diameter, the maximum spacing between manholes is 330 feet.
 - b. For manholes 33 inches to 45 inches in diameter, the maximum spacing between manholes is 440 feet.
 - c. For manholes greater than or equal to 48 inches in diameter, the maximum spacing between manholes is 600 feet.

H. Special Junction Structures:

1. To minimize head loss, join opposing storm drain laterals greater than 24 inches in diameter using a special junction structures designed by a registered Professional Engineer to be hydraulically efficient and to withstand HS-20 loading.

I. Cover or Fill Over Storm Drains:

1. The structural design of the pipe for any depth of cover is based on an unlimited trench condition.
2. Provide pipe and fittings designed to withstand trench loadings and conditions imposed by each location.
3. For reinforced concrete pipe, the minimum cover from the top of the pipe to finished grade is 2 feet, and the maximum cover is 12 feet.



- a. For pipe installed under railroad tracks, provide the minimum cover as specified in the railroad permit or as shown on the Contract Drawings, whichever is the more stringent.
 4. For high density polyethylene (HDPE) pipe, the minimum and the maximum cover from the top of the pipe to finished grade is to be as shown on the Contract Drawings or is to be in accordance with the manufacturer's recommendations, whichever is more stringent.
 - a. For high density polyethylene (HDPE) pipe installed in streets, provide a minimum of 2.0 feet of cover.
 5. Unless otherwise indicated, ensure cover or fill over storm drains is a minimum of 5 feet, and falls within the allowable ranges indicated in the Figure titled "Required "D" Load For Reinforced Concrete Pipe - Positive Projection Condition" in the City of Phoenix Storm Water Policies and Standards.
 - a. Determine "D" loads assuming a 140 pound per cubic foot load.
 - b. For up to 10 feet of cover in ordinary soil conditions, assume positive projected conditions.
 - c. For trenches deeper than 10 feet in ordinary soil conditions, assume trench conditions unless soil information indicates unstable soil, in which case assume positive projected conditions.
- J. Product Data and Shop Drawings:
 1. Prepare and submit completely dimensioned Shop Drawings, layout drawings, catalog cut sheets, and other data required to completely describe the proposed piping, piping specialties, and valves to the Program/Project Manager for approval.
 - a. Specify the maximum inside annular space satisfying the requirements specified in this Section in the Product Data and Shop Drawings.
 - b. With the valve Product Data, include information about the performance and operation of the valve, materials of construction, flow data, dimensions and weights, head loss data, and pressure ratings.

2.02 MATERIALS

- A. Concrete Pipe:
 1. Reinforced Concrete Pipe (RCP):
 - a. Provide reinforced concrete pipe manufactured from water, Portland cement, pozzolanic materials, mineral aggregates, and reinforcing steel complying with the requirements specified in ASTM C 76, except as follows:
 - 1) Concrete Mix:
 - a) Proportion the mix so that there is not less than 564 pounds of Portland cement, or a combination of Portland cement and pozzolanic materials, per cubic yard of the mix.



- (1) If pozzolanic materials are used, 17.5 percent of the combined weight of the pozzolanic materials and Portland cement must be approved pozzolanic materials.
 - b) Portland Cement:
 - (1) Provide Type II, low alkali Portland cement complying with the requirements of ASTM C 150.
 - (2) Submit a cement mill certificate for each load of cement delivered to the concrete pipe fabrication plant indicating the specification, type, chemical analysis, and quantity of cement, or the stockpiled pipe manufacturer's certification that the type of cement used to manufacture pipes complies with the specified requirements.
 - c) Pozzolanic Materials:
 - (1) Provide pozzolanic materials complying with the requirements of ASTM C 618 and Section 725.2.1, "Pozzolanic Materials", of the MAG Uniform Standard Specifications for Public Works Construction.
 - d) Concrete Admixtures:
 - (1) If approved by the Program/Project Manager, concrete admixtures may be use; however, do not use calcium chloride or an admixture containing calcium chloride.
 - (2) Submit the pipe manufacturer's certification that calcium chloride or an admixture containing calcium chloride was not used in the pipe concrete mix, and include the brand and chemical content of the admixtures used.
- 2) Concrete Reinforcement:
 - a) Provide steel concrete reinforcement complying with the requirements of Section 03200, Concrete Reinforcement.
 - b) Provide an area of steel as indicated on the approved Shop Drawing for that pipe.
 - (1) In reinforced concrete pipe having less than 36 inches inside diameter, include reinforcing steel in the bell not less than the area required for the circumferential reinforcement in the wall of the pipe.
 - c) Submit the pipe manufacturer's mill certificates showing heat numbers, chemical analysis, and physical tests on the reinforcing steel supplied; or for stockpiled pipe, submit the pipe manufacturer's certification that the type of steel used to manufacture the reinforced concrete pipe complies with the specified requirements.
2. Non-Reinforced Concrete Pipe (NRCP):
 - a. Provide non-reinforced concrete pipe of the size and Classes indicated on the Contract Drawings or specified for the item of Work.



- b. Provide concrete pipe manufactured as specified in ASTM C 14 for Strength Class 1, 2, or 3 non-reinforced concrete pipe, except as follows:
 - 1) If not otherwise shown or specified, provide Class 3 pipe.
- c. Concrete Mix:
 - 1) Provide materials as specified in ASTM C 14, except provide Type II, low alkali, cement complying with the requirements specified in ASTM C 150.
 - 2) Water-Cement Ratio: Less than 0.53.
 - 3) Submit a cement mill certificate for each load of cement delivered to the concrete pipe fabrication plant indicating the specification, type, chemical analysis, and quantity of cement, or the stockpiled pipe manufacturer's certification that the type of cement used to manufacture pipes complies with the specified requirements.
- 3. Joints for Reinforced Concrete Pipe (RCP) and Non-Reinforced Concrete Pipe (NRCP):
 - a. For concrete pipes having diameters smaller than 48 inches, joints may be either O-ring gasket joints or profile gasket/single offset joints.
 - b. For concrete pipes having diameters 48 inches and larger, joints may be tongue in groove, O-ring gasket joints, or profile gasket/single offset joints.
 - c. Gaskets for Reinforced Concrete Pipe (RCP) and Non-Reinforced Concrete Pipe Joints:
 - 1) Provide continuous ring gaskets of a size and cross section that completely fill the recess provided for it to seal the joint.
 - a) Provide gaskets that have smooth surfaces, free from pits, blisters, porosity, and other imperfections which would adversely affect sealability.
 - b) Provide gaskets designed to be the sole element making the joint watertight.
 - 2) Provide gaskets manufactured only from composition rubber containing not less than 60 percent by volume of first grade synthetic rubber, with the remainder of the composition consisting of pulverized fillers free from rubber substitutes, reclaimed rubber, and deleterious substances; and having the following properties:
 - a) Tensile Strength (Minimum): 2100 psi when measured in accordance with ASTM D 412.
 - b) Elongation at Rupture (Minimum): 400 percent when measured in accordance with ASTM D 412.
 - c) Hardness (Shore Durometer, Type A): 40 to 60 plus or minus 5 when measured in accordance with ASTM D 2240.
 - d) Cold Flow: 20 percent or less when measured in accordance with Method B as specified in ASTM D 395, except use a disc 1/2 inch thick and having the same diameter as the rubber gasket.



- (1) Do not expose the gaskets to direct sunlight longer than needed to install the gasket normally.
 - e) Specific Gravity: Between 0.95 and 1.45 when measured in accordance with ASTM D 297, but measuring consistently within plus 0.05 of the value.
- d. Grout/Cement Mortar Mix for Reinforced Concrete Pipe (RCP) and Non-Reinforced Concrete Pipe (NRCP) Joints:
 - 1) Provide grout/cement mortar consisting of Portland cement, sand, and water mixed to produce a soft workable mortar as follows:
 - a) For normal mortaring and grouting, mix 1 part Portland cement to 2 parts sand by volume.
 - b) For outside joints made by the “diaper” method, mix 1 part Portland cement to 3 parts sand by volume mixed to the consistency of thick cream.
 - c) Do not exceed a water-cement ratio of 0.53
 - 2) Cement:
 - a) Provide Portland cement conforming to the requirements for Type II, low alkali, cement specified in ASTM C 150.
 - 3) Sand:
 - a) Provide thoroughly and uniformly washed sand entirely free of oil and deleterious substances, and sufficiently free of organic material, mica, loam, clay and other deleterious substances to be suitable for constructing pipe.
 - b) Provide sand sized and graded in accordance with the requirements of ASTM C 144.
 - c) Provide sand having a sand equivalent, determined by averaging the value from 3 successive samples tested as specified in ASTM D 2419, not less than 70.
 - (1) No individual sample may have a sand equivalent less than 65.
 - 4) Water:
 - a) Provide water clean and free of injurious amounts of oils, acids, alkalis, salts, organic materials, and other substances deleterious to concrete or concrete reinforcement.
 - 5) Submit the design mixes for mortar/grout to the Program/Project Manager for approval.
- 4. Cast-In-Place Concrete Pipe (CIPP):
 - a. Provide cast-in-place concrete pipe (CIPP) constructed from Portland cement concrete cast monolithically in a properly prepared trench using equipment specifically designed for the purpose.
 - b. Concrete and Bonding Mortar Mixes:
 - 1) Concrete:
 - a) Provide Class A concrete as specified in Section 03300, Cast-In-Place Concrete, except use the sand aggregate specified herein and provide concrete having the minimum required



- slump for satisfactory placement of the concrete using the approved equipment, but not more than 3 inches.
- 2) Bonding Mortar:
 - a) Provide bonding mortar consisting of 2 or more parts of cement to 3 parts of sand by volume.
 - c. Cement:
 - 1) Provide Portland cement conforming to the requirements for Type II, low alkali, cement specified in ASTM C 150.
 - d. Water:
 - 1) Provide water clean and free of injurious amounts of oils, acids, alkalis, salts, organic materials, and other substances deleterious to concrete or concrete reinforcement.
 - e. Sand Aggregate:
 - 1) Provide thoroughly and uniformly washed sand entirely free of oil and deleterious substances, and sufficiently free of organic material, mica, loam, clay and other deleterious substances to be suitable for constructing pipe.
 - 2) Provide sand sized and graded in accordance with the requirements of ASTM C 33.
 - a) Do not provide aggregate greater than 1-1/2 inches.
 - b) Do not provide aggregate greater than 1/3 the minimum wall thickness for pipe wall thicknesses up to and including walls 4-1/2 inches thick.
 - 3) Provide sand having a sand equivalent, determined by averaging the value from 3 successive samples tested as specified in ASTM D 2419, not less than 70.
 - a) No individual sample may have a sand equivalent less than 65.
 - f. Pipe Dimensions:
 - 1) Construct cast-in-place concrete pipe (CIPP) so the internal diameter at any point is not less than 95 percent of the nominal diameter, and the average of any 4 measurements internal diameter made at 45 degree intervals is not less than the nominal diameter.
 - 2) Minimum Wall Thickness:
 - a) For pipe with inside diameter less than 15 inches: 2 inches.
 - b) For pipe with inside diameter 15 inches to 24 inches: 2-1/2 inches.
 - c) For pipe with inside diameter exceeding 24 inches: 1/12 the inside diameter plus 1 inch.
 - 3) Offsets at Form Laps and Horizontal Edges:
 - a) For pipe with inside diameter 42 inches and less: 1/2 inch.
 - b) For pipe with inside diameter greater than 42 inches but not greater than 72 inches: 3/4 inch.
 - c) For pipe with inside diameter exceeding 72 inches: 1 inch.



- g. Joints:
 - 1) Construct joints as specified in Subparagraph 3.03.G.2.
- B. Corrugated Steel Pipe (CSP):
 - 1. Provide Type II corrugated steel pipe (CSP), pipe-arches, and connectors as specified in AASHTO M 36 and indicated on the Contract Drawings.
 - a. Type II pipe, as specified herein, has a single thickness of corrugated sheet and a full circular cross section having helical corrugations that has been reformed into a pipe-arch having an approximately flat bottom.
 - b. Provide the spelter coating, method of sampling, accepted brands of metal, sheet manufacturer's certified analysis and guarantee, workmanship, marking, inspection, and rejection in accordance with the requirements of AASHTO M 36.
 - c. Steel Sheet for Pipe:
 - 1) Fabricate the corrugated steel pipe from flat aluminum-coated Type 2 steel sheet, complying with the requirements of AASHTO M274, in coils.
 - 2) Sheet Thickness:
 - a) Provide sheet thickness that will provide a 75-year design life to the first perforation based on soil conditions as indicated in Table 6.15.5 in the City of Phoenix Storm Water Policies and Standards.
 - b) Minimum Sheet Thickness: 14 gage.
 - d. Fabrication Seams:
 - 1) Provide a continuous lock or weld seam extending from end to end of each length of pipe.
 - 2) Fabricate seams so the shape and nominal diameter of the pipe is unaffected, and so they do not create weakness in the pipe.
 - 2. Coating and Lining:
 - a. Uniformly coat the exterior of the pipe with a full bituminous coating as specified for Type A pipe in AASHTO M 190, and line the entire interior of the pipe with Portland cement concrete.
 - 1) Apply the Portland cement concrete at the plant to produce a homogeneous, non-segregated lining having a mechanical trowel finish.
 - a) Provide a minimum lining thickness of 1/8 inch above the crest of the corrugation.
 - 2) Portland Cement Content of Concrete, Minimum: 564 pounds per cubic yard.
 - 3) Sand: Provide sand sized and with a gradation in accordance with ASTM C 33.
 - 4) For bituminous coated pipe, provide a smooth and neat exterior pipe coating a minimum of 0.050 inches thick both on the pipe and on the connecting band permitting the connecting band to properly seat and lock into angular corrugations and compress the gasket.



- b. Equip corrugated steel pipe arches and pipe, whether elliptical or round, that have an external coating or internal lining with lifting lugs.
- 3. Dimensions:
 - a. Provide corrugated steel pipe (CSP) conforming to the dimensions indicated in Table 8 and Table 9 in AASHTO M 36.
 - b. Dimensional Tolerances:
 - 1) For pipe having internal diameters between 12 and 24 inches, pipe may not vary more than plus or minimum 1.5 percent from the design diameter.
 - 2) For pipe having internal diameters between 27 and 108 inches, pipe may not vary more than plus or minimum 1.0 percent or 3/8 inch from the design diameter, whichever is greater.
- 4. Joints:
 - a. Provide watertight bituminous coated couplers or coupling bands constructed as specified in AASHTO M 36, and fabricated from galvanized steel 2 numerical gages lighter than the gage specified for the pipe material, but not less than 0.064 inches (16 gage) or more than 0.109 inches (12 gage).
 - 1) Provide annular corrugated type bands or hugger type bands locking in at least 1 annular corrugation, and designed to form a leak-resistant joint.
 - a) Connecting Band Width:
 - (1) For pipe diameters 12 inches to 30 inches: 7 inches.
 - (2) For pipe diameters 33 inches to 60 inches: 10-1/2 inches.
 - (3) For pipe diameters greater than 60 inches to 120 inches: 13-1/2 inches.
 - b) Provide coupling bands that overlap the pipe ends by a minimum of 2 inches.
 - c) For pipe having diameters up to and including 48 inches, one-piece bands may be used.
 - d) For pipe having diameters exceeding 48 inches, use multi-piece bands.
 - e) Design the annular corrugated type bands to accommodate a 1/4 inch thick sleeve gasket the same width as the connecting band.
 - f) Design the hugger type band to accommodate an o-ring gasket.
 - 2) Corrugated or Dimpled Couplers or Coupling Bands:
 - a) Fabricate the couplers or coupling bands to either have corrugations or dimples that match the pipe corrugations or end treatments, or that are flat.
 - (1) Provide corrugated steel pipe arches and pipe, whether elliptical or round, that have an external coating or internal lining with a positive connection that will not damage the coating on the pipe or pipe arch.



- b) Dimpled Couplers:
 - (1) Shape dimples so they conform to the general shape of the standard pipe corrugations.
 - (2) For nominal pipe diameters 12 through 60 inches, provide dimpled coupling bands that are 10-1/2 inches wide, and that have 2 rows of dimples with not less than 7 dimples per row.
 - (3) For nominal pipe diameters 60 through 96 inches, provide dimpled coupling bands that are 17 inches wide, and that have 4 rows of dimples with not less than 7 dimples per row.
 - (4) Provide dimple arrangements that allow a maximum spread.
- c) Connecting angles for both dimpled and standard corrugated coupling bands may be riveted; but dimpled coupling bands may have slotted angles in lieu of rivets.
- 3) Plain Flat Coupling Bands and Spiral Rib Flange Bands:
 - a) For nominal pipe diameters 12 through 60 inches, provide coupling bands that are 10-1/2 inches wide.
 - b) For nominal pipe diameters 60 through 96 inches, provide coupling bands that are 17 inches wide.
 - c) Flat coupling bands having a single circumferential corrugation rolled in each edge to match a similar corrugation in the end of each pipe may be 10-1/2 inches wide regardless of the pipe diameter.
 - d) If flanges are provided on pipe ends, provide couplings having a preformed channel band or other type of band incorporating a locking channel not less than 3/4 inches wide for interlocking the flanges.
 - (1) Depth of Locking Channel: 1/2 inch, minimum.
 - (2) Locking Channel Thickness: 0.079 inches.
- 4) Provide bolts for fastening the couplers or coupling bands together to join pipe sections.
 - a) Attach coupling bands using 1/2-inch nominal diameter carriage bolts as follows:
 - (1) For pipe up to 36 inches in diameter, and for flat coupling bands having a single circumferential corrugation rolled in each edge to match a similar corrugation in the end of each pipe regardless of the pipe diameter: 2 bolts.
 - (2) For pipe 36 to 60 inches in diameter: 3 bolts.
 - (3) For pipe over 36 inches in diameter: 5 bolts.
- b. Gaskets:
 - 1) Provide O-ring gaskets complying with the requirements of ASTM C 361.



- a) For pipe having diameters up to and including 48 inches, provide O-ring gaskets having a 3/4-inch diameter, minimum.
 - b) For pipe having diameters exceeding 48 inches, provide O-ring gaskets having a 7/8-inch diameter, minimum.
 - 2) Provide 1/4 inch thick closed cell rubber sleeve gaskets complying with the requirements for Grade SCE 43 as specified in ASTM D 1056, and the same width as the connecting band.
- 5. Fittings:
 - a. For lateral pipes larger than 24 inches, provide prefabricated welded fittings.
- C. Ductile Iron Pipe (DIP) and Fittings:
 - 1. Provide ductile iron pipe (DIP) and fittings complying with the requirements specified in the MAG Uniform Standard Specifications for Public Works Construction and the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - a. Provide ceramic epoxy lined ductile iron pipe (DIP) and fittings complying with the requirements specified in Section 750.2, "Ductile Iron Water Pipe", of the MAG specification as modified by the COP Supplement.
 - b. Provide ceramic epoxy lining of the ductile iron pipe and fittings complying with the requirements specified in Section 750, "Lining for Ductile Iron Sewer Pipe and Fittings" of the COP Supplement.
- D. High Density Polyethylene (HDPE) Pipe and Fittings:
 - 1. Provide corrugated high-density polyethylene pipe and fittings manufactured in compliance with the requirements of ASTM F 894, AASHTO M 252, or AASHTO M 294.
 - a. Provide Type S corrugated HDPE pipe which is defined in AASHTO M 252 and AASHTO M 294 as having a full circular cross section, an outer corrugated pipe wall and a smooth inner liner, and annular or helical corrugations.
 - b. Allowable HDPE Corrugated Pipe Materials:
 - 1) Fabricate the pipe from Class PE335420C or higher polyethylene plastic compound as defined in ASTM D 3350.
 - c. Dimensions:
 - 1) Provide corrugated HDPE pipe and fittings whose dimensions are the nominal inside diameter.
 - 2) Do not provide corrugated HDPE pipe and fittings whose nominal inside diameter dimensions deviate from its nominal pipe size by more than the minimum and maximum tolerances allowed in AASHTO M 252 or Section 7.2.3 of AASHTO M 294.
 - d. Pipe Stiffness (PS):
 - 1) Provide corrugated HDPE pipe and fittings having the pipe stiffness (PS) indicated in Section 7.5 of AASHTO M 252 or in Section 7.4 of AASHTO M 294, but not less than the equivalent



- PS value for the ring stiffness constant of profile pipe having a pipe classification RSC 63 (RSC equals 56 pounds per foot of length) as defined in ASTM F 894.
- 2) Determine the PS in accordance with ASTM D 2412 with the exceptions listed in AASHTO M 252 or AASHTO M 294.
2. HDPE Pipe Joints:
- a. Provide either gasket type or weld type watertight joints for HDPE pipe.
- b. Gasketed Joints:
- 1) Provide a piping system consisting of integral bell and spigot joints designed so a gasket placed on the spigot is compressed radially on the pipe or fitting bell to form a watertight seal against exfiltration and infiltration when the joint is assembled.
- a) Provide gaskets complying with the physical requirements specified in ASTM F 477.
- b) Ensure that all surfaces on which the gasket will bear are smooth and free of imperfections which would adversely affect sealability.
- c) Design the joint so that the gasket is not displaced from the joint during assembly or while the pipeline is in service.
- 2) Provide a home mark on the spigot end of the pipe to indicate when proper penetration into the bell end has been achieved when the joint is made.
- 3) Provide clamp gaskets at manhole entries or connections to reduce exfiltration and infiltration.
- c. Welded Joints:
- 1) Provide welded joints only if specified or shown on the Contract Drawings.
- 2) Provide a piping system consisting of integral bell and spigot joints, with or without elastomeric centering gaskets, designed to be joined together by using an extrusion welding process.
- a) Extrusion welds may be made inside the pipe, outside the pipe, or both inside and outside the pipe.
- b) Assemble welded joints in accordance with the pipe manufacturer's recommendations.
- 3) Welding Material:
- a) Provide welding material for thermally welding pipe materials that is compatible with the base material being welded.
- d. If HDPE pipes are joined to precast manholes, provide holes in the manhole large enough to allow proper grouting with a non-shrink grout around the manhole gasket.
3. Fittings:
- a. Provide fittings having bell and spigot configurations compatible with those used for the pipe.



- b. Provide clamp gaskets or other approved means at manhole entries or connections to reduce infiltration and exfiltration.
 - 4. Identification:
 - a. Clearly mark the following information on each pipe in accordance with the requirements of ASTM F 894, AASHTO M 252, or AASHTO M 294 at intervals of approximately 12 feet:
 - 1) Manufacturer's name or trademark.
 - 2) Nominal size.
 - 3) Specification designation.
 - 4) Plant designation code.
 - 5) Date of manufacture or an appropriate code.
 - 6) For corrugated HDPE pipe manufactured according to AASHTO M 294, also include the Plastic Pipe Institute Mark on each length of pipe that complies with PPI Third Party Certification Program requirements.
 - b. Mark fittings with the manufacturing specification designation and the manufacturer's identification symbol.
 - 5. Lubricants:
 - a. Provide lubricant for assembling the pipes complying with the pipe manufacturer's recommendations.
 - b. Provide lubricant that is compatible with both the pipe and the gasket materials so no detrimental effects to the pipe or gasket will occur.
 - 6. Water Stops:
 - a. Provide water stops complying with the requirements specified in ASTM C 923; with expansion rings, a tension band, or a take-up device to mechanically compress the water stop against the pipe.
 - b. Provide water stops manufactured from natural or synthetic rubber.
 - 7. Gaskets:
 - a. Provide gaskets complying with the physical requirements specified in ASTM F 477.
 - b. Gaskets for HDPE pipe may be manufactured from natural rubber, synthetic elastomer, or a blend of both.
- E. Bedding Materials:
 - 1. Provide bedding materials complying with the requirements specified in Section 02316, Trenching and Backfilling.
- F. Backfill Materials:
 - 1. Provide backfill materials complying with the requirements specified in Section 02316, Trenching and Backfilling.
- G. Concrete:
 - 1. Provide concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete, unless otherwise specified in this Section.



H. Sheet Curing Material:

1. Provide sheet curing material that will not affect the concrete finish, or lessen the concrete strength.
2. Provide polyethylene film sheet conforming to the requirements of ASTM C 171.
 - a. Nominal Thickness: 0.0015 inch.

I. Pipe Specials:

1. Provide pipe specials, such as closure pieces, wyes, tees, bends, and manhole shafts as indicated on the Contract Drawings.
2. Fabricate the pipe specials equal in strength, diameter, and other physical characteristics to the standard straight pipe lengths by using extra concrete, reinforcing, steel, or other materials.
3. Submit Shop Drawings of pipe specials to the Program/Project Manager to receive approval of each item prior to its fabrication.

J. Valves:

1. Duckbill Valves:

- a. Provide duckbill check valves designed to eliminate backflow and seal around entrapped solids.
 - 1) Taper the inlet area to a straight duckbill which allows flow in only one direction.
- b. Provide duckbill check valves designed to be inserted into existing pipes, and to be secured in place using internal expandable Type 304L stainless steel cuff-type clamps that exert a compressing force against the valve material between the clamp and the internal surface of the pipe as they are expanded.
 - 1) Provide duckbill check valves that when installed maintain at least 75 percent of the full port area of the pipe.
- c. Provide one piece duckbill valve tubes fabricated from all-elastomer or fabric reinforced elastomer having excellent corrosion and abrasion resistance.
 - 1) Provide tubes fabricated from NSF 61-approved materials.
- d. Size the duckbill valves as indicated on the Contract Drawings.
- e. Manufacturers:
 - 1) J & S Valve, Inc., Model DBV-09-SI, <http://www.jandsvalve.com/>.
 - 2) General Rubber Corporation, Style 4350, <http://www.general-rubber.com/>.
 - 3) Tideflex Technologies, Series 37G, <http://www.tideflex.com>.
 - 4) Manufacturer providing an equivalent product approved by the Program/Project Manager.

2.03 FABRICATION

A. Shop Fabrication:

1. Cement Pipes:



- a. Prior to manufacturing reinforced concrete pipe (RCP) or non-reinforced concrete pipe (NRCP), submit 4 sets of layout drawings to the Program/Project Manager for approval.
 - 1) For tongue in groove concrete pipe, indicate the maximum annular space between the tongue and groove that provides 50 percent overlap of the manufacturer's designed full seat position.
 - 2) Show pipe stubs.
 - 3) Either show catch basin connector pipe, or furnish a list of catch basin connector pipes that includes the following:
 - a) Pipe size and D-load.
 - b) The station where the pipe joins the main line.
 - c) The number of the section of pipe, the length of the section, and the type of section such as straight, horizontal bevel, vertical bevel, or other similar description.
- b. Mixing and Placing Concrete:
 - 1) Store the cement for manufacturing reinforced concrete pipe (RCP) or non-reinforced concrete pipe (NRCP) in a watertight, dry, well-ventilated structure.
 - 2) Do not use cement having a temperature above 150 degrees Fahrenheit to fabricate cement pipes until the cement cools below that temperature.
 - 3) Do not use cement salvaged by cleaning cement sacks to manufacture cement pipes.
 - 4) Do not use cement containing lumps to manufacture cement pipes.
- c. Curing Reinforced Concrete Pipe (RCP) or Non-Reinforced Concrete Pipe (NRCP):
 - 1) Do not commence curing reinforced concrete pipe (RCP) or non-reinforced concrete pipe (NRCP) until the concrete has attained its initial set, but not sooner than 1 hour or later than 8 hours after the concrete was placed.
 - 2) Either steam curing or water curing can be used.
 - a) Steam Curing:
 - (1) Furnish an adequate steam plant, piping, enclosures, and other curing facilities for curing the concrete pipe.
 - (2) Maintain the temperature between 110 and 150 degrees Fahrenheit in the enclosures.
 - b) Water Curing:
 - (1) If the reinforced concrete pipe (RCP) or non-reinforced concrete pipe (NRCP) is not immediately water cured after placing the concrete, except for the joint surfaces that will be grouted, seal the surfaces of the concrete with an approved white pigmented sealing compound complying with the *material* requirements specified in Section 726, "Concrete Curing materials", in the MAG



Uniform Standard Specifications for Public Works Construction.

- (2) Keep the reinforced concrete pipe (RCP) or non-reinforced concrete pipe (NRCP) wet during daylight hours.
 - (a) Unless the concrete pipe is kept constantly and completely wet with fog sprays during daylight hours, cover the concrete pipe, including the ends, with burlap for the first 3 days after placing the concrete.
- 3) Limit the temperature rise of the concrete to 30 degrees per hour.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Tests:

- a. Certain materials require testing according to the methods referenced below, or as required by Program/Project Manager, in compliance with Section 01400, Quality Requirements.
 - 1) Each pipe manufacturer must have facilities to perform the tests listed.
 - 2) The Program/Project Manager reserves the right to require the manufacturer to perform an additional number of tests as the Program/Project Manager deems necessary to establish the quality of the material offered for use.
- b. Factory testing of the pipe materials may be witnessed by the Program/Project Manager:
 - 1) Concrete Pipe Hydrostatic Tests:
 - a) At the discretion of the Program/Project Manager, hydrostatic tests may be required for reinforced concrete pipe (RCP) and/or non-reinforced concrete pipe (NRCP).
 - (1) Submit certification of the hydrostatic leak tests performed for all pipe joints.
 - b) Test Procedure:
 - (1) Hydrostatically test reinforced concrete pipe (RCP) and/or non-reinforced concrete pipe (NRCP) in accordance with the test methods specified in ASTM C 14.
 - c) Acceptance Criteria:
 - (1) Reinforced concrete pipe (RCP) and non-reinforced concrete pipe (NRCP) meeting the requirements specified herein will be acceptable.
 - 2) Duckbill Valve Hydrostatic Tests:
 - a) Test Procedure:
 - (1) Have a certified testing laboratory perform hydraulic tests on a minimum of 4 valves similar in design and stiffness as those proposed for the work of this Contract to validate



- the headloss characteristics, flow capacities, and jet velocities.
- b) Acceptance Criteria:
 - (1) Have the laboratory submit certified test reports certifying that the values on the manufacturer's published Product Data are accurate to the Program/Project Manager for information.
 - 3) Loading Test:
 - a) Test Procedure:
 - (1) Load test non-reinforced concrete pipe in accordance with the test methods specified in ASTM C 14.
 - b) Acceptance Criteria:
 - (1) Non-reinforced concrete pipe meeting the requirements specified herein will be acceptable.
 - 4) Acceptance Test for Standard Design Reinforced Concrete Pipe:
 - (1) Test Procedure:
 - (a) If the modified or special design method specified in ASTM C 76 is elected for designing the pipe, refer to Subparagraph 2.04.A.1.b.2.b. for acceptance on the basis of material tests and inspection of manufactured pipes for defects and imperfections.
 - (b) Test reinforced concrete pipe in accordance with the test methods specified in ASTM C 76.
 - (c) Concrete cylinders may be made and tested to determine the general quality of the concrete and release dates for shipping the pipe.
 - (2) Acceptance Criteria:
 - (a) Acceptance will be based on the criteria specified in ASTM C 76, the Specifications, and the following:
 - i. Slump must be less than 4 inches to preclude excessive segregation of the materials and so homogeneous concrete will result.
 - ii. The opening crack resulting from the D-Load Test must be relatively parallel to the pipe axis, and when measured at close intervals must not exceed 0.01 inch for a distance of 1 foot.
 - 5) Acceptance Test for Modified or Special Design Reinforced Concrete Pipe:
 - a) Test Procedure:
 - (1) For reinforced concrete pipe designed according to the modified or special design method of ASTM C 76, test the pipe in accordance with the procedures specified in Section 735.7.L of the MAG Uniform Standard Specifications for Public Works Construction.



- (2) This test procedure is permitted to be performed only once for each pipe manufacturer.
 - (3) The Program/Project Manager will select 1 joint of each size and D-load to test.
 - (4) Each joint selected will be tested for strength by the 3 edge bearing method specified in ASTM C 497.
 - (5) Do not place reinforcing steel in the test section to control shear cracks.
 - b) Acceptance Criteria:
 - (1) Edge bearing test results that confirm the design for the D-load will indicate the pipe represented by the test is acceptable; pipe sections failing in compression or shear before reaching the specified D-load are unacceptable.
 - (2) If a section fails the test, additional sections of the same size diameter and class may be tested until the D-load requirements are achieved.
 - (3) Slump must be less than 4 inches to preclude excessive segregation of the materials and so homogeneous concrete will result.
 - (4) The opening crack resulting from the D-Load Test must be relatively parallel to the pipe axis, and when measured at close intervals must not exceed 0.01 inch for a distance of 1 foot.
 2. Inspections:
 - a. The Program/Project Manager may inspect the pipe at the mill or warehouse where the pipe and pipe materials are manufactured or stored.
- B. Non-Conforming Work:
1. Reinforced Concrete Pipe:
 - a. Porous or honeycomb areas of the concrete 6 inches or less in diameter may be repaired; pipe having porous or honeycomb areas greater than 6 inches in diameter are unacceptable, and are reason to reject the pipe in question.
 - b. Cracks in the Pipe:
 - 1) Cracks exceeding 1 foot in length that go completely through the pipe are unacceptable, may not be repaired, and are cause for rejecting the pipe, except that a single end crack not exceeding the depth of the joint measured from the end to the inside shoulder is acceptable.
 - 2) Cracks that are 0.01 inch wide, 1/16 inch deep or deeper, and at least 1 foot long are unacceptable; and are reason to reject the pipe in question.
 - a) A single hairline crack less than 0.01 inch wide, and not extending to the reinforcing steel for at least 1 foot long are acceptable without repair.



- c. Blisters:
 - 1) Pipe joints having blisters larger than 1/4 of the interior surface are unacceptable, pipe joints having blisters 1/4 or less of the interior surface may be repaired.

C. Manufacturer Services:

- 1. Corrugated Steel Pipe (CSP) Preconstruction Demonstration:
 - a. For Contracts using concrete-lined corrugated steel mainline storm drain pipe, perform a preconstruction demonstration at the pipe manufacturer's plant prior to installing the pipe.
 - 1) Perform the demonstration in the presence of the Contractor's Superintendent and pipeline installer, the Program/Project Manager, and a representative of the pipe manufacturer.
 - 2) Demonstration Procedure:
 - a) Connect 2 pieces of pipe using O-rings and hugger bands in accordance with the manufacturer's recommendations for watertight installations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Prior to performance of the actual work, carefully inspect the entire Site.
 - 2. Locate existing exposed and buried active utilities, and determine the requirements for their protection, or their disposition with respect to the Work of this Section.
 - a. Prior to performing excavation operations, contact Arizona Blue Stake to verify the location or existence of buried utilities and avoid damage to the utilities.
 - 1) Arizona Blue Stake may be contacted by telephone at (602) 263-1100.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
 - 2. Conduct construction operations in a manner that prevents injury to adjacent buildings, structures, other facilities, and persons.
 - a. If public safety could be endangered during the progress of the construction work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
 - 1) Provide warning signs, signals, and barricades conforming to requirements of Federal, State and local laws, rules, regulations, precautions, orders, and decrees.



- b. Leave all sidewalks, curbs, pavement, and shoring of these and similar items in place and properly braced except as otherwise indicated in the Contract Drawings.
 3. Maintain existing utilities indicated to remain on the Contract Drawings, and protect them against damage.
 - a. Coordinate with the local utility companies for necessary relocation of utilities.
 - b. Protect existing fire control hydrants and repair damaged hydrants.
 - c. If a conflicting utility not shown on the Contract Drawings is discovered during the course of the Work, notify the Program/Project Manager as soon as possible.
 - 1) The Program/Project Manager will negotiate to have the owner of the conflicting utility relocate it, have others relocate the utility, change the alignment or grade of the trench to avoid the conflict, or declare the work to resolve the conflict as extra work.
 4. Unless otherwise indicated in the Contract Documents, maintain all underground and overhead utilities in continuous service throughout the duration of the Contract, and take responsibility and accept liability for damages or interruptions of service caused by the construction.
 - a. Keep all active utilities in service.
 - 1) Protect active utilities, improvements, and services from damage.
 - b. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the authorities having jurisdiction.
 - c. During interruptions to existing utilities, provide temporary services acceptable to governing authorities.
 - d. Provide permanent pipe supports for sewer, water, and other utility lines where shown on the Contract Drawings and at other locations as deemed necessary by the Program/Project Manager.
 - 1) Provide permanent pipe supports in accordance with the details shown on the Contract Drawings, the MAG Uniform Standard Details for Public Works Construction, and the Phoenix Supplemental Standard Details for Public Works – Construction.
 - e. Adequately support electronic, telephonic, telegraphic, electrical, oil, and gas lines encountered; and avoid damaging plastic pipe, pipe-way, and conduits during foundation preparation, bedding placement and backfilling operations.
 - 1) Support plastic pipe and electrical conduit continuously along the bottom of the pipe or conduit.
 - 2) Support metal pipe and electrical conduit either continuously or suspend the pipe or conduit from nylon webbing spaced at intervals not more than 10 feet apart.
 - f. If a utility or appurtenance is to be temporarily or permanently relocated or shut down, the Contractor is responsible for making the necessary arrangements and agreements with the owner of the utility and its reconstruction at no increase in the Contract Price.



- 1) Reconstruct the utility or appurtenance and the property to its previous condition or better as soon as possible.
- 2) The relocation or shutdown and restoration cycle is subject to inspection and approval by both the Program/Project Manager and the owner of the utility.

B. Surface Preparation:

1. Dust Control:

- a. Control fugitive dust by applying an adequate dust palliative, such as water, to the ground and debris in an amount sufficient to maintain dust as incidental to demolition and lot clearing operations in accordance with the requirements of the Maricopa County Air Pollution Regulations and with the requirements of other authorities having jurisdiction.
 - 1) Sprinkle water, use temporary enclosures, and employ other suitable methods to limit dust and dirt rising and scattering into the air to the lowest practical level.

2. Trench Excavation:

- a. Perform the excavation required for the installation of piped storm drainage as specified in Section 02613, Trenching and Backfilling.
 - 1) If the trenches are over-excavated, fill the trench with select materials complying with the requirements specified in Section 02721, Aggregate Base Course, and as shown on Detail No. P1200 and others Details as applicable in the Phoenix Supplemental Standard Details for Public Works – Construction.
 - 2) When the fine grading of trench bottoms is being performed, ensure that the trench is dry.
- b. Cast-In-Place Concrete Pipe (CIPP) Trench Excavation:
 - 1) Excavate trenches for the cast-in-place concrete pipe (CIPP) with neat vertical sides and semi-circular bottoms shaped to form the bottom outside of the pipe on the alignment, and to the grades indicated on the Contract Drawings.
 - a) Shape the bottom to provide the full form of the pipe, and to provide uniform support of the bottom 210 degrees of the pipe circumference by undisturbed earth or compacted fill.
 - b) The tolerance for departure from and return to the established grade of the finished pipe trench and the invert of the installed pipe is 1 inch in 10 linear feet, and a maximum allowable departure of 0.10 foot.
 - (1) Departure from and return to the specified alignment for the trench and pipe may not exceed the allowable tolerances specified for the grade.
 - c) The density of the fill must be at least 5 percent greater than the natural in-place soil, but not less than 85 percent when tested in accordance with Method A of AASHTO T 99 and AASHTO T 191, or ASTM D 2922 and ASTM D 3017.



- 2) If the cast-in-place concrete pipe (CIPP) must be installed in rocky areas, areas where sand sloughs off, or areas where soft or spongy soil is encountered, then remove the rock, and or soft or spongy soil by over-excavating the objectionable material, and providing and compacting suitable fill material to leave a minimum 6-inch cushion of compacted soil between the excavated trench and the pipe.
 - a) Completely fill areas left void by rock removal with compacted fill, then re-excavate the trench for the pipe.
 - b) If the rock below the subgrade is fractured or fragmented, or if it consists of large cobblestones or boulders, then select the replacement fill to have a gradation that will not settle downward caused by fluctuations in the water table.
 - c) Do not use expansive soils for fill.
- 3) If the cast-in-place concrete pipe (CIPP) must be installed in areas where expansive clay is encountered, thoroughly moisten the clay and maintain the moisture by ponding to completely expand the soil until the concrete is placed.
- 4) Reinforced concrete pipe (RCP) or unreinforced concrete pipe may be substituted for the cast-in-place concrete pipe (CIPP) in the unsuitable areas.
- c. Excavate trenches in rock at least 25 feet in advance of pipe laying operations.
3. Prior to placing bedding or laying pipe in trenches, remove water and debris from the finished trench.

3.03 INSTALLATION

- A. Installation in State highway right-of-way must conform to Arizona Department of Transportation permits and the requirements of the ADOT Standard Specifications for Road and Bridge Construction.
- B. Installation or pipe in the laterals of the Salt River Valley Water Users' Association Salt River Project (SRP) or other irrigation districts must conform to permits and specifications of SRP or the respective irrigation district.
- C. Pipe Bedding:
 1. Place and compact bedding for storm drain lines in accordance with the requirements of Section 02316, Trenching and Backfilling, as shown on the Contract Drawings, or as otherwise indicated, except as follows:
 - a. Before pipe joints are made, bed each section of pipe for the full length of the barrel.
 2. Special Bedding for Mainline Storm Drain Pipe:
 - a. Except for cast-in-place concrete pipe (CIPP) and catch basin connector pipes, bed mainline storm drain pipe in a controlled low



strength material (CLSM) as specified in Section 02316, Trenching and Backfilling.

- 1) Provide CLSM having a minimum slump of 8 inches, and a compressive strength between 25 psi and 100 psi based on a 28-day test.
 - b. Place the controlled low strength material (CLSM) at least from the outside bottom of the pipe to the springline of the pipe.
 - c. The Contractor may elect to excavate a trench having a cross section with a rounded rather than a flat bottom, if a 6-inch minimum clearance between the outside wall of the pipe and the trench wall is maintained.
 - 1) The minimum trench clearance on each side of the pipe at the pipe springline for all pipe sizes may be reduced from the clearance to specified in Section 02316, Trenching and Backfilling, to 6 inches if this option is elected.
 - d. The Contractor may elect to provide either controlled low strength material (CLSM) or crushed aggregate bedding materials as specified in Section 02316, Trenching and Backfilling, from the pipe springline to 1 foot over the outside top of the pipe.
 - 1) If this option is elected for high density polyethylene (HDPE) pipe or for corrugated steel pipe (CSP), the leakage test for pipes embedded using this option is not required.
3. Pipe Bedding Compaction:
- a. If water consolidation of the bedding is allowed by the Program/Project Manager, the bedding for conduits 24 inches or less in inside diameter may be placed in a single lift, but for larger conduits the first lift may not exceed the spring line of the pipe.
 - b. For mechanical consolidation of the bedding, the moisture content of the bedding must be within the range of plus 2 percent to minus 4 percent of the optimum moisture content prior to the material being placed.
 - 1) The first lift may either be 8 inches or 2/3 of the distance to the spring line of the pipe, whichever is greater.
 - 2) Lifts succeeding the first lift may not exceed 1 foot of material in the un-compacted, loose state.
 - 3) Prevent damage to and movement of the conduit by the compaction equipment.
 - c. When placing pipe bedding for high density polyethylene (HDPE) pipe and fittings, deposit the bedding material in loose lifts of 8 inches or less, and thoroughly and carefully compact the bedding material equally around both sides of the pipe.
 - 1) Use approved vibratory compactors, or other tools and equipment where applicable; or shovel slicing if approved by the Program/Project Manager, to reach compaction densities as



specified in Section 02316, Trenching and Backfilling, or as otherwise been shown on the Contract Drawings.

- 2) Continue this procedure until enough material has been placed and compacted to reach the top of the corrugated HDPE pipe.

D. Laying Pipe:

1. Furnish and use proper and suitable tools and appliances for properly and safely handling and lowering pipe into trenches and laying the pipe.
2. Provide pipe of the type, class, and size indicated on the Contract Drawings.
3. Lay pipe firmly, proceeding upgrade true to line and grades indicated on the Contract Drawings.
 - a. Use a laser to facilitate installing storm drain lines to the line and grades indicated.
 - b. Lay bell and spigot pipe with the spigot end pointing in the direction of flow.
 - c. Lay tongue and groove pipe with the groove end upgrade.
4. Ensure that each length of pipe abuts against the next so that no shoulder or unevenness of any kind occurs along the inside bottom half of the pipeline.
 - a. To prevent sudden offsets of the flow line, lay each pipe to form a close concentric joint with the adjoining pipe.
5. When pipe is being laid, no wedging or blocking is permitted unless by written order of Program/Project Manager.
 - a. Make adjustments to line and grade, scrape away or fill in under the body of the pipe.
6. Excavate recesses so the pipe invert forms a continuous grade with the invert of the pipe previously laid.
7. Dig bell holes sufficiently large to permit proper joint making, and to ensure the pipe is firmly bedded for the full length of its barrel.
8. High Density Polyethylene (HDPE) Pipe Installation:
 - a. Install high density polyethylene (HDPE) pipe in accordance with the requirements of ASTM D 2321 or the manufacturer's recommendations.
 - b. If the pipe is out-of-round, orient the pipe so the long axis is vertical when the pipe is installed in the trench.
9. Corrugated Steel Pipe (CSP) Installation:
 - a. Do not lay corrugated steel pipe (CSP) except in the presence of the Program/Project Manager's inspector.
 - 1) To determine if damage has been done to the exterior coating that will be concealed once the pipe is placed, each length of pipe will be carefully inspected immediately prior to its being placed in the trench.
 - b. Install elliptical pipe so the major or minor axis, as the case may be, coincides with the survey alignment of the trench excavation.



- 1) The major and minor axes should be indicated by suitable markings on the top of each end of the pipe section.
- c. Lay corrugated steel pipe (CSP) and/or pipe arches so the outside laps of circumferential joints point upstream, longitudinal laps are on the side, and the joint space between separate sections does not exceed 1/2 inch.
- d. Where a curved alignment is indicated in the corrugated steel pipe (CSP), form the curve using straight pipe and specials.
 - 1) Provide pipe lengths so no deflection angle in the pipeline exceeds 10 degrees.
 - 2) Locate deflection angles between the point of curvature and the point of tangent of the curve as shown on the Contract Drawings.
- e. Pipe Elongation:
 - 1) Take advantage of the buildup of side support as a pipe settles back toward a full round shape under the backfill load, elongate pipe 5 percent of the nominal diameter plus or minus 1/2 percent.
 - a) Methods or techniques for achieving and releasing the elongation are at the option of the Contractor.
 - 2) After backfill placement and compaction is completed, do not allow the vertical dimension of the pipe to be less than the nominal diameter of the pipe, or more than 5 percent greater than the nominal diameter shown on the Contract Drawings or specified elsewhere in this Section.
- f. Cutting corrugated steel pipe (CSP):
 - 1) Whenever possible, fabricate connections in the shop to minimize fire hazards caused by field cutting operations.
 - 2) Either saw cut the pipe, or use special tools that will not expose the pipe to the fire hazard of a normal acetylene torch to cut the pipe.
 - a) Due to the fire hazard posed by conventional cutting torches, their use to cut the pipe is prohibited.
- g. Apply bituminous mastic to metal in the joints not thoroughly protected, to coupling band bolts, and to damaged areas of the coupling bands and pipe prior to placing the backfill on the pipe.
10. Locate fittings as shown on the Contract Drawings, or as directed by the Program/Project Manager, and install them in accordance with the MAG and COP Standard Details.
11. After setting each length of pipe, verify the alignment and grade of the by measuring from a laser beam target, string line, or other means approved by the Program/Project Manager.

E. Joining Pipe:

1. Keep trenches water-free during joint and coupling installation.
2. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
3. Gasketed Joints:



- a. Prior to making gasketed joints, clean, dry, and prepare the joint surfaces in accordance with the manufacturer's recommendations; and carefully center the joints.
 - b. Make joints absolutely watertight.
4. Reinforced Concrete Pipe (RCP) and Non-Reinforced Concrete Pipe (NRCP) Joints:
 - a. Cement Mortar or Grout Joints:
 - 1) O-ring gasket and profile gasket/single offset joints do not need to be mortared and grouted.
 - 2) Tongue in groove joints need to be butted together and mortared and grouted as follows:
 - a) Thoroughly clean and wet pipe ends before placing mortar and grout.
 - b) Overlap the tongue in the groove portion not less than 50 percent of the manufacturer's designed full seat position.
 - c) Unless the pipe is used on curves or angle points, tongue in groove joints do not need to be grouted on the outside.
 - (1) For curves or angle points, grout the outside of the pipe, or provide a concrete collar, as determined by the Program/Project Manager.
 - d) If the joints need to be grouted, completely fill the annular space between pipe section with mortar, and finish the inside pipe surface so it is smooth.
 - (1) Fill the entire depth of the finished joint with mortar so a strong, tight joint results.
 - e) Do not mortar joints until the next 2 joints are in place.
 - f) Cure mortar joints by keeping them wet for 3 days, or by using an approved curing compound.
5. High Density Polyethylene (HDPE) Pipe Joints:
 - a. Furnish wood blocking to protect high density polyethylene (HDPE) pipe when the HDPE pipe jointing is performed by pipe jacking, back hoe bucket, come-along, or cable pipe puller.
6. Corrugated Steel Pipe (CSP) Joints:
 - a. Join corrugated steel pipe (CSP) together using annular corrugated type bands or hugger type bands that lock in at least 1 annular corrugation.
 - 1) Tighten the bands evenly by keeping equal tension on the bolts.
 - b. Keep corrugated steel pipe (CSP) joints uncovered for a period of time designated by the Program/Project Manager so the nuts can be tested for tightness.
 - 1) If a nut loosens its grip on its bolt, retighten it and keep the joint uncovered until the connection's tightness can be retested.
 - 2) Once a tight, permanent joint is obtained, the joint may be covered.



- a) Prior to backfilling around the joint, coat the bolts, lugs, and nuts with bituminous mastic.
 - c. After bituminous coated pipe has been joined, fill the annular space between the abutting pipe sections with bituminous mastic.
 - d. After concrete lined pipe has been joined, mortar the internal joints completely around the pipe to a smooth trowel finish.
- 7. Joints for Ductile Iron Storm Drain Pipe:
 - a. Assemble storm drain pipe joints in accordance with the manufacturer's installation instructions and indicated reference standards.
- 8. Provide horizontal and vertical long-radius curves formed using bevel adapters or by beveling the strait pipe joint.
 - a. Provide bevels not exceeding 5 degrees, and limit the total angular deflection for beveled pipe to 10 degrees.
 - b. Small angular changes may be made with straight pipe provided the joint opening does not exceed 3/4 inch.
- 9. Provide horizontal and vertical short-radius curves formed using fabricated specials.
 - a. Limit the angular deflection of each segment of the fabricated section to 10 degrees.
- 10. Joint Deflections:
 - a. Pulling joints to deflect mainline storm drain pipe is only allowed if the manufacturer's specifications for horizontal deflection and tolerances are indicated on the Contract Drawings.
 - b. A vertical or horizontal angular bend in catch basin connector pipe up to and including 22-1/2 degrees may be made in accordance with Detail No. 505 in the MAG Uniform Standard Details for Public Works Construction.
 - c. Provide prefabricated pipe bends for deflections in catch basin connector pipes greater than 22-1/2 degrees.
- 11. Submit the manufacturer's joint preparation instructions.

F. Duckbill Valves:

- 1. Install the duckbill valves in accordance with the manufacturer's installation recommendations and instructions.
 - a. Submit the duckbill valve manufacturer's installation recommendations and instructions to the Program/Project Manager for information.
- 2. Insert the duckbill check valves into existing pipes where shown on the Contract Drawings.
- 3. Align the bill opening so it is vertical to maintain symmetrical loading on each side of the valve.
 - a. Do not rotate the valve out of vertical alignment to avoid peripheral interferences.

G. Backfilling and Compaction:



1. Backfill and compact storm drain lines in accordance with the requirements of Section 02316, Trenching and Backfilling.
 - a. For high density polyethylene (HDPE) pipes having nominal diameters from 8 inches to 120 inches, and which have bedding and backfill consisting of coarse aggregate, use only mechanical compaction methods to consolidate the bedding and backfill.
 - 1) Do not use water consolidation for compacting coarse aggregate, whether the coarse aggregate is used as a foundation, bedding, or backfill material.
 - 2) If other than coarse aggregate is used as backfill material, use mechanical compaction methods to consolidate the backfill.
 - a) Water consolidation may be used to compact backfill materials other than coarse aggregate only when prior approval to do so is received from the Program/Project Manager.
2. Do not backfill around mortared and grouted joints until the joints have been fully inspected and approved.

H. Special Techniques:

1. Jacking Pipe:
 - a. At locations where pipe is to be installed by boring and jacking pipe, follow the requirements specified in Section 02445, Boring or Jacking Conduits, with the following additional requirements:
 - 1) Where pipe is indicated on the Contract Drawings to be bored and jacked into place, provide reinforced concrete or other pipe of the strength specified.
 - a) Provide circular reinforcing steel of either a single or double cage design in the concrete conduit.
 - b) The design strength indicated is based upon the superimposed loads, and not upon loads imposed on the pipe as a result of jacking operations; any increase in conduit strength necessary for the conduit to withstand additional loading due to boring and jacking operations is the responsibility of the Contractor to determine.
 - 2) Provide conduit manufactured with 3 grout holes per 8-foot section of pipe.
 - 3) Place spacer blocks in the inside circular space between concrete conduit sections to equalize the pressure during jacking operations, and to allow sufficient width for point mortaring once the jacking operation is completed.
 - 4) For steel pipe 36 inches in diameter and larger, provide band type joints and double rubber gaskets.
 - 5) Make 1 hole located on the top of the concrete conduit midway between the ends of the bored and jacked conduit, and make 2 additional holes each located approximately 1.5 feet from each end and midway between the springline and top on opposite sides of the conduit.



2. Constructing Cast-In-Place Concrete Pipe (CIPP):
 - a. Do not construct cast-in-place concrete pipe (CIPP) unless the Program/Project Manager is present.
 - b. Construct cast-in-place concrete pipe with as few starts and stops as possible.
 - 1) Operate the cast-in-place concrete pipe machine at speeds and in a manner to smoothly and steadily place concrete.
 - 2) Schedule material deliveries to support continued production.
 - c. Furnish an anchoring system for the pulling system of the cast-in-place concrete pipe machine to minimize the probability of deviations in grade and/or alignment.
 - 1) Adjust or modify the anchoring system when required in the opinion of the Program/Project Manager.
 - d. Prior to placing concrete in the trench, adequately moisten the soil in the trench prior to placing concrete in the trench so water is not drawn from concrete freshly placed, and thoroughly moisten forming devices, including slipforms and the hopper of the placement device.
 - 1) Keep the trench free of excess water, mud, and debris.
 - e. Ensure that means of removing sloughed material, debris, and other foreign objects from the trench before and during concrete placement so material does not build up in front of the cast-in-place concrete pipe machine.
 - 1) Dig small transverse trenches across the trench bottom spaced no more than 25 feet apart to receive soil that builds up and is pushed ahead of the slipform.
 - f. Monolithically construct the entire cross section of the pipe in 1 placement.
 - 1) Furnish inside forms that are sufficiently rigid to withstand consolidation of the fresh concrete.
 - 2) Place concrete so a thoroughly consolidated homogeneous concrete mixture is produced.
 - a) Apply an effective means to consolidate fresh concrete within the pipe shell and over its entire circumference.
 - b) Furnish means of placing and consolidating fresh concrete at production speeds, while providing sufficient pressure to effectively bond the concrete to the surrounding earth and keep loose sand, mud, and water out of the pipe shell.
 - g. If the vibrators on the cast-in-place concrete pipe machine become inoperable, cease installing the pipe immediately; and do not furnish portable vibrators or stingers as the sole source of consolidation.
 - 1) Only use portable vibrators or stingers to supplement the internal vibrators on the cast-in-place concrete pipe machine.
 - h. Construction Joints:
 - 1) Whenever pipe placement ceases for longer than 90 minutes, form a construction joint as follows:



- a) For joints that will connect to another pipe or structure, square off the end of the pipe, and excavate along the sides and bottom of the pipe to permit casting a concrete collar around the construction joint.
- b) For joints that will not connect to another pipe or structure, slope the pipe ends so the ends slope between 20 and 45 degrees.
- c) Leave the ends that will butt against the next concrete placement in a rough condition.
 - (1) For pipes 42 inches or less in diameter, embed Number 4 reinforcing steel bars at 12 inches on center in the current pour, and extended them 12 inches into the space for next pour.
 - (2) For pipes greater than 42 inches in diameter, embed Number 4 reinforcing steel bars at 18 inches on center in the current pour, and extended them 12 inches into the space for next pour.
- d) Immediately prior to resuming concrete placement, clean the surface to be bonded of all laitance, coatings, foreign materials, and loose or defective concrete; and thoroughly wet and apply a 1/4-inch thick coating of bonding mortar, or wet and scrub neat cement paste onto the surface of the previously placed concrete.
- i. Curing Cast-In-Place Concrete Pipe (CIPP):
 - 1) Cure the cast-in-place concrete pipe while preventing premature drying of the concrete.
 - 2) Immediately after the pipe is cast, anchor sheet curing material in place on the exposed top surface of the pipe by using loose soil to assure continuous and adequate curing.
 - 3) Maintain a humid atmosphere within the pipe, indicated by condensation forming on the interior surface of the pipe, for at least 7 Days following placement, except during the 24 hour period allowed for removing forms and making repairs.
 - a) Except when work is in progress inside the pipe, keep all openings, ends, manholes, and connector pipes closed or securely covered to prevent drafts which may dry the pipe and to maintain a humid atmosphere in the pipe.
 - b) During the curing period when work is not being performed on the inside of the pipe, partially fill the pipeline with water.
- j. Removing Cast-In-Place Concrete Pipe (CIPP) Formwork:
 - 1) If metal inner forms were used, remove the forms within 4 to 6 hours of placing concrete, and start repairing, finishing, and patching the pipeline to conform to specified requirements.
 - 2) If pneumatically inflated inner liner is used to form the cast-in-place concrete pipe, remove the pneumatic inner liner within 12



- hours of placing concrete, and start repairing, finishing, and patching the pipeline to conform to specified requirements.
- k. Backfilling Cast-In-Place Concrete Pipe (CIPP):
 - 1) Do not finally backfill the cast-in-place concrete pipe and compact the backfill until the concrete has developed a compressive strength of at least 3000 psi.
 - 2) After the pipe has properly cured, backfill and compact the fill to an even grade.
 - l. Finishing Cast-In-Place Concrete Pipe (CIPP):
 - 1) Except for the form offsets, provide a better than wood float finish on the interior of the pipe.
 - 2) Trim form offsets to provide a reasonably tapered slope from surface to surface.
 - 3) Finish the bottom of the pipe below the metal forms to conform to the general circular circumference of the pipe without sags, dips, and humps.
 - 4) Remove all extraneous concrete from the interiors surface.
3. Structures:
- a. Provide inlets, manholes, and similar reinforced concrete structures to be built underground as part of the storm sewer as indicated on the Contract Drawings, MAG Standard Details, and COP Standard Details; and that comply with the material requirements specified in Section 505, Concrete Structures, in the MAG Uniform Standard Specifications for Public Works Construction.
 - 1) Provide castings that comply with the *material* requirements specified in Section 787, Gray Iron Castings, in the MAG Uniform Standard Specifications for Public Works Construction as modified by the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 2) Provide reinforcing steel that complies with the requirements specified in Section 03200, Concrete Reinforcement.
 - 3) Storm drain manhole shafts constructed in accordance with MAG Standard Detail No. 522, Storm Drain Manhole Shaft, except that unreinforced 6-inch thick precast Class A concrete shaft pipe and cones are substituted for the 4-inch wall thickness shown in the Detail, and that do not include the steps are acceptable.
 - b. Provide through manholes, lateral manholes, or transition manholes at the locations indicated on the Contract Drawings, complete in place including the required base, shaft, reinforced concrete rings, frames and covers, concrete caps, frame adjustment to grade, and similar items as indicated on the Contract Drawings and Phoenix Supplemental Standard Details for Public Works - Construction.
 - 1) Do not install steps in the manholes; if steps have been installed, remove them and fill the holes with Class B concrete or epoxy.
 - c. Structures in Corrugated Steel Pipelines:



- 1) For manholes larger than 48 inches in diameter in corrugated steel pipelines, the Contractor may elect to construct transition manhole bases using a prefabricated transition manhole base cast with a 48-inch stubbed manhole shaft as 1 structure having dimensions equivalent to those shown on Detail No. P1560 in the Phoenix Supplemental Standard Details for Public Works - Construction.
 - a) If this option is elected, submit a Shop Drawing of the storm drain manhole base to the Program/Project Manager for approval.
 - (1) Corrugated steel manholes are not permitted unless a detail of the construction is included with the Shop Drawing and approved by the Program/Project Manager.
- 2) Layout manholes in corrugated steel pipe (CSP) so the outside edge of the manholes not located at a joint are a minimum of 1.5 pipe diameters away from the nearest joint on both sides of the manhole.
 - a) For manholes unable to be located at joints or a minimum of 1.5 pipe diameters away from the nearest joint on both sides of the manhole, extend the concrete encasement of the manhole to include the joint or joints inside the 1.5 diameter distance from the manhole shaft.
- 3) The maximum angle for a catch basin connector pipe to exit a catch basin wall is 22-1/2 degrees from perpendicular.
4. Connecting Extensions to Existing Mainline Storm Drains:
 - a. Prior to extending an existing mainline storm drain, verify the depth, size, type of pipe, and horizontal location of the existing storm drain in the field.
 - 1) If the new pipe extension is the same type and size of the existing mainline storm drain, or if the new pipe's manufacturer makes a standard watertight adapter fitting specifically manufactured to join their pipe to the existing mainline storm drain pipe type, a standard connection recommended by the manufacturer may be provided; otherwise, provide a concrete field collar to connect the pipes as shown on Detail No. 505 in the MAG Uniform Standard Details for Public Works Construction.
5. Connecting Connector Pipes to Existing Mainline Storm Drains:
 - a. Join connector pipes to existing mainline storm drains either at manholes or in accordance with Detail No. P1577 in the Phoenix Supplemental Standard Details for Public Works – Construction, or to cast-in-place pipe in accordance with Detail Number P1576 in the Phoenix Supplemental Standard Details for Public Works – Construction, or if a new reinforced concrete connector pipe whose outside diameter is greater than 1/2 the inside diameter of the existing reinforced concrete pipe main, in accordance with Detail No. P1578 in



the Phoenix Supplemental Standard Details for Public Works – Construction.

- 1) Do not use Detail No. 524, Storm Drain Lateral Pipe Connections, in the MAG Uniform Standard Details for Public Works Construction.
6. Connecting Pipes to New Storm Sewers:
 - a. When connecting pipes to new storm sewers, keep inlet connecting pipes and lateral pipes temporarily plugged until all facilities downstream have been completed to the satisfaction of the Program/Project Manager.
 - b. Connect existing storm sewers to new storm sewers at the locations indicated on the Contract Drawings, but keep the existing storm sewers intact or provide a bypass until the mainline downstream has been completed to the satisfaction of the Program/Project Manager.
 - c. Connect new mainline pipe to new mainline pipe at manholes, or special junction structures, depending on size.
 - d. Connect new mainline pipe to existing mainline pipe at manholes, special junction structures, or in accordance with Detail No. P1578 in the Phoenix Supplemental Standard Details for Public Works – Construction depending on size and the feasibility of installing the manhole or special junction structure.
7. Connecting Storm Sewers to Catch Basins:
 - a. Connect catch basin connector pipes to new mainline storm drain pipes using prefabricated tees.
 - b. One catch basin connector pipe may be joined to the mainline at a manhole if the standard required mainline manhole spacing provides a convenient location for it.
 - c. Minimize headloss and maintain the structural integrity of the mainline pipe by offsetting opposing catch basin connector pipes a minimum of 5 feet horizontally as measured from the centerline of each connector pipe.
 - 1) If there are 2 directly opposing catch basins connecting to a mainline, in the vicinity of a manhole, only 1 connector pipe may connect to the manhole and the second connector pipe must connect to the mainline at a prefabricated tee located at least 5 feet downstream of the manhole.
- I. Tolerances:
 1. Line and Grade: Plus or minus 0.10 feet.
 2. Rate of departure from or return to established grade or alignment: Less than 1 inch in 10 feet of pipe, unless otherwise approved by the Program/Project Manager.



3.04 REPAIR

- A. Remove and relay pipe that is out of alignment or grade, and pipe having disturbed joints after being laid.
- B. Remove in-place pipe sections that are found to be defective, and replace the removed pipe sections with new, good pipe.
 - 1. If any section of bored and jacked conduit shows signs of failure, remove and replace it with a new section of precast concrete conduit or with a cast-in-place concrete section.
 - a. The new precast concrete conduit or cast-in-place concrete sections must be approved by the Program/Project Manager as being adequate to carry the structural loads imposed upon them before being installed.
- C. Concrete Pipe Repair:
 - 1. Cracks allowed to be repaired may be repaired either by pressure injecting epoxy into the crack, or by chipping out a V-section to the full depth of the defect, and filling the void with an approved patching compound.
 - a. Submit the patching compound to the Program/Project Manager for approval prior to using it.
 - b. Cracks wider than 0.01 inch are assumed to indicate overstress of the reinforcing steel, and methods to repair or replace such cracks require the approval of the Program/Project Manager.
 - 1) After structural repairs have been completed, remaining cracks can be repaired as specified.
 - 2. Blisters allowed to be repaired may be repaired by first removing all loose material from the blistered area to expose the hollow area, next filling the void with fresh concrete properly bonded by using an acceptable bonding agent, then curing the repair using a membrane coating.
 - 3. Unless approved by the Program/Project Manager, using a grout "paint-like" coating to cover minor or major defects in concrete pipe is unacceptable.
- D. Cast-In-Place Concrete Pipe (CIPP) Repair:
 - 1. Clean out, moisten, and fill all rock pockets, non-longitudinal cracks, or indentations in cast-in-place concrete pipe using 1:2 cement grout or an approved epoxy material.
 - 2. Repair longitudinal cracks as required, except where, in the opinion of the Program/Project Manager, the width or length of the crack indicates a structural deficiency.
 - a. Subject to approval by the Program/Project Manager, cracks may be repaired using a pressure applied epoxy compound capable of providing structural correction to the area in addition to sealing the void.



3. Regardless of the method used to place the concrete, complete all repairs, patching, and finishing within 24 hours of placing the concrete.

E. Corrugated Steel Pipe (CSP) Repairs:

1. Repair damage to the spelter coating of corrugated steel pipe (CSP) using a zinc dust-zinc oxide coating conforming to the requirements of AASHTO M 36 and to the weight and uniformity specified in ASTM A 929/A 929M.
 - a. Repair damage resulting from strutting as directed by the Program/Project Manager at no increase in Contract Price.
2. For bituminous coated corrugated steel pipe (CSP), field repair damage to the bituminous coating or paving with approved fiber reinforced bituminous mastic to the satisfaction of the Program/Project Manager.
3. For concrete lined corrugated steel pipe (CSP), repair cracks 1/16 inch or more in width and 36 inches or more in length using an approved epoxy to the satisfaction of the Program/Project Manager.
4. Remove corrugated steel pipe (CSP) that has been damaged to the extent that, in the opinion of the Program/Project Manager, it cannot be field repaired; and replace the pipe removed with acceptable pipe at no increase in Contract Price.

F. Ductile Iron Pipe (DIP) Lining Repair:

1. Repair damaged sections of the lining of ductile iron pipe (DIP) used for sewer pipe in accordance with the requirements of Section 750.1, "Lining for Ductile Iron Sewer Pipe and Fittings", in the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.

3.05 RESTORATION

- A. Replace pavement and surfacing disturbed by storm drain installation activities in accordance with the requirements specified in Section 02316, Trenching and Backfilling.

3.06 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:
 - a. Leakage Test:
 - 1) High Density Polyethylene (HDPE) Pipe and Corrugated Steel Pipe (CSP):
 - a) After the first 3 installed joints of high density polyethylene (HDPE) pipe and corrugated steel pipe (CSP) mainline pipe have their bedding placed to 1 foot above the pipe, leak test the joints.
 - 2) Corrugated Steel Pipe (CSP):



- a) For concrete lined corrugated steel pipe (CSP), do not perform the leakage test until all internal joints have been filled or mortared.
 - (1) If the Contractor elects to place slurry from the springline of concrete-lined corrugated steel pipe (CSP) to 1 foot over the outside top of storm drain pipe, the leakage test for that section of pipe is not required.
- 3) Have the Material Testing Laboratory test the completed storm drain sections for leakage.
- 4) Test Procedure:
 - a) Seal off the downstream end of the line, and fill the line with water to a minimum head of 4 feet in a standpipe at the high end.
 - b) Before starting the test, allow the test section to absorb water for a period of 1 hour.
 - c) A meter or other suitable means will be used to measure the quantity of water used and lost from the line.
 - d) Allow at least 1 additional hour to perform the test after the initial hour allowed for the test section to absorb water elapses.
- 5) Acceptance Criteria:
 - a) The allowable water loss for storm drainage lines is 1.0 gallon per hour per 100 feet of pipe per inch of diameter of pipe when subjected to a head of 4 feet at the upper end of the pipe.
 - b) The allowable water loss for irrigation lines is 2.0 gallons per hour per 100 feet of pipe per inch of diameter of pipe when subjected to a head of 1 foot at the upper end of the pipe.
 - c) Storm drains leaking at a greater rate fail the test and are unacceptable.
- b. Cast-In-Place Concrete Pipe (CIPP) Wall Thickness Test:
 - 1) Test Procedure:
 - a) The top, bottom, and side wall thicknesses of cast-in-place concrete pipe (CIPP) will be randomly measure at intervals spaced approximately 100 feet along the pipeline by inserting probes into fresh concrete or small holes drilled through the concrete.
 - b) The CIPP Wall Thickness Test will be performed on a daily basis.
 - c) Properly and permanently close and seal the holes after the testing is completed flush with the inside surface of the pipe using the repair procedures specified in this Section.
 - 2) Acceptance Criteria:
 - a) Walls having the specified thicknesses are acceptable.
- c. Cast-In-Place Concrete Pipe (CIPP) Strength Test:



- 1) Test Procedure:
 - a) Test cylinders will be prepared as specified in the Concrete Strength Test for New Concrete in Section 03300, Cast-In-Place Concrete.
 - b) If the cylinder tests performed in accordance with the Concrete Strength Test for New Concrete indicate the concrete does not have the specified strength, then 14 days after the concrete was placed, cores will be taken from the section of the concrete represented by the faulty test cylinder in accordance with the Concrete Strength Test for Concrete in Place Concrete in Section 03300, Cast-In-Place Concrete, under the supervision of the Program/Project Manager.
 - (1) The diameter of the cores *should* be at least 3 times the maximum nominal size of the “coarse aggregate” used, and *must* be twice the maximum nominal size of the “coarse aggregate” used.
 - (2) The length of each specimen when capped should be twice the core diameter; do not test cores having a maximum height less than 95 percent of its diameter after capping.
 - c) If cores are taken, patch all core holes so the patch is permanent, will not leak, and has a smooth interior finish flush with the interior surface of the pipe.
- 2) Acceptance Criteria:
 - a) The strength level of the concrete cylinders will be considered satisfactory so long as the average of all sets of 3 consecutive compressive strength test results equal or exceed the specified strength f'_c , and no individual strength test result falls below the specified strength f'_c by more than 500 psi.
 - b) Concrete in the area represented by a core test will be considered adequate if the average compressive strength of the cores is equal to at least 85 percent of the specified strength f'_c , and if no single core is less than 75 percent of the specified strength f'_c .
- d. Corrugated Steel Pipe (CSP) Bituminous Coating Tests:
 - 1) Secure Samples from corrugated steel pipe (CSP) delivered, or about to be delivered, to the Contractor; or from the coating and lining facility of the pipe fabricator at the time the pipe is being coated.
 - 2) Test Procedure:
 - a) Test the bituminous coating to verify it complies with the requirements specified in AASHTO M 190 for material and thickness.
 - 3) Acceptance Criteria:



- a) Bituminous coatings complying with the requirements specified in AASHTO M 190 are acceptable.
 - b) Submit copies of the Corrugated Steel Pipe (CSP) Bituminous Coating Test results to the Program/Project Manager for information.
 - 2. Inspections:
 - a. Corrugated Steel Pipe (CSP):
 - 1) Immediately prior to laying corrugated steel pipe (CSP) in the trenches, carefully inspect the pipe for defects.
 - b. Cast-In-Place Concrete Pipe (CIPP):
 - 1) Prior to placing concrete in the trenches excavated for the cast-in-place concrete pipe (CIPP), inspect the alignment and grade of the trenches.
 - a) Submit the proposed method for controlling and verifying conformance of the grade and alignment of the trenches to the specified values to the Program/Project Manager for approval.
 - 2) Immediately following the removal of the formwork, inspect the inside of the pipeline for defects requiring repairs and for conformance to dimensional requirements.
 - a) Longitudinal cracks exceeding 0.01 inch in width and 12 inches long may, at the discretion of the Program/Project Manager, be cause for rejection, removal, and reconstruction of the defective portion of the pipeline.
 - b) The Program/Project Manager is the sole judge of whether deficiencies can be repaired or not.
 - c. High Density Polyethylene (HDPE) Pipe and Fittings:
 - 1) Inspect HDPE pipe for out of roundness.
 - 2) HDPE pipe out-of-round in excess of 3 percent of the nominal pipe diameter is unacceptable.
 - d. Prepare as-built information for the storm drainage system, and submit it to the Program/Project Manager as a record document.
- B. Non-Conforming Work
 - 1. Remove and reconstruct sections of cast-in-place concrete pipe (CIPP) the Program/Project Manager judges to be non-repairable or which are not within dimensional, alignment, grade, and/or strength tolerances.
 - 2. Do not install HDPE pipe that is out-of-round in excess of 3 percent of the nominal pipe diameter, and remove installed pipe found to be unacceptable and replace it with acceptable HDPE pipe.
 - 3. If the pipe under test fails a leakage test, repair or replace the failed section, and retest the repaired section.
 - a. Methods of repair are subject to the Program/Project Manager's approval.
 - b. Immediately repair detected leaks and defects in joints.



4. Reject corrugated steel pipe (CSP) found to be defective during inspections.

3.07 CLEANING

- A. In order to leave the pipeline clean and free from debris, garbage, rubbish, stones, deposits, and similar foreign materials, swab the conduits, flush them with water, or use other approved methods to clean the pipes.

3.08 PROTECTION

- A. Temporary Pipe Closure:
 1. At the end of each workday, place a temporary closure at the open end of all pipes.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 02637

UTILITY TRENCH DRAINS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for utility trench drains.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Water Works Association (AWWA):
 - 1. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch (76 mm Through 1,219 mm), for Water.
 - 2. AWWA C111/A21.11 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 3. AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile-Iron Pipe.
 - 4. AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile-Iron Pipe.
 - 5. AWWA C151/A21.51 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
 - 6. AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings, 3 In. (76 mm) Through 64 In. (1,600 mm), for Water Service.
- B. City of Phoenix (COP):
 - 1. City of Phoenix Storm Water Policies and Standards.
- C. State of Arizona:
 - 1. Arizona Administrative Code (AAC):
 - a. AAC R18-9-A301 through E323 – Title 18 Environmental Quality, Chapter 9 Department of Environmental Quality Water Pollution Control, Article 3 Aquifer Protection Permits - General Permits.
 - b. AAC R18-9-A901 through C905 – Title 18 Environmental Quality, Chapter 9 Department of Environmental Quality Water Pollution Control, Article 9 Arizona Pollutant Discharge Elimination System.
 - 2. Arizona Department of Environmental Quality (ADEQ):
 - a. ADEQ 2008 Construction General Permit SWPPP Guidance Checklist.
- D. United States Government:
 - 1. United States Code (U.S.C.):



- a. 33 U.S.C. Section 1251 et seq.
 - 1) Water Quality Act of 1987, Public Law 100-4.
 - 2) Clean Water Act of 1977, Public Law 95-217.
 - 3) Federal Water Pollution Control Act Amendments of 1972, Public Law 95-500.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the material sizes and installation methods of the utility trench drains with the block-outs provided in the substrates for the trench drains.
- B. Scheduling:
 - 1. Ensure that the block-outs for the utility trench drains are constructed prior to the scheduled installation of the trench drains so the Work is not delayed.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Trench drain system components and accessories.
 - b. Shop Drawings:
 - 1) Trench drain system.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Trench drain system manufacturer's storage and handling recommendations.
 - 2) Trench drain system manufacturer's recommended method(s) for suspending the assemblies in block-outs or trenches.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. The Work of this section is subject to approvals before it can be put into service and accepted as follows:
 - a. If the Project impacts water bodies, a Clean Water Act, Section 404 permit will be required by the U.S. Army Corps of Engineers.
 - b. Compliance with the Arizona Pollution Discharge Elimination System (AZDES) general permit for storm water discharges from construction sites is required.



- c. Compliance with the City of Phoenix Storm Water Policies and Standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. To protect the external spigot end of ductile iron pipes against abrasion and damage during shipping and handling, furnish temporary protective collars on the exterior of each spigot end of each pipe section.
 - a. Secure the temporary protective collars to the pipe to prevent accidental removal during shipping and normal handling by the Contractor.
 - b. Do not remove the temporary collars until immediately before the pipe is to be installed or field cut.
- B. Storage and Handling Requirements:
 - 1. Store and handle the utility trench drains and their accessories in accordance with the manufactures recommendations.
 - 2. Submit the trench drain system manufacturer's storage and handling recommendations to the Program/Project Manager for information.
- C. Packaging Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 TRENCH DRAIN SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Zurn Industries, LLC, Z886-HD PERMA-TRENCH® LINEAR TRENCH DRAIN SYSTEM, www.zurn.com/operations/flothru.
 - b. Approved equal.
 - 2. Product Options:
 - a. Provide slotted grates similar to the Zurn P6-DGC- Wide Grate Item 14.
- B. Description:
 - 1. Provide a trench drain system consisting of modular channel sections having interlocking ends, radiused bottoms, and a built-in slope suitable for embedment in concrete slabs, and having a frame assembly for supporting removable drain grates.
- 2. Regulatory Requirements:
 - a. Comply with the requirements of the City of Phoenix Storm Water Policies and Standards.
- C. Performance:
 - 1. Provide a trench drain system capable of handling flow rates up to 88 gallons per minute at the location with the shallowest depth.

RFI 0736 FW Trench Drain Grate Clarification

RFI 0893 FW Trench Drain Grate Clarification



D. Design Criteria:

1. Provide a lightweight sloped trench drain system.
2. Submit Product Data for the trench drain system, including its components and accessories, to the Program/Project Manager for approval.
3. Submit Shop Drawings of the trench drain system, including its layout and sequence, details, and component identification, to the Program/Project Manager for approval.
 - a. Include unique identification numbers for each component of the system on the Shop Drawings.

E. Materials:

1. Frame:
 - a. Provide heavy-duty frames having anchor studs designed for embedment in the surrounding concrete attached, and having tie straps laterally spanning the frame.
 - b. Provide a system for properly aligning the trench drain frame and modular channel sections within the blockout or trench constructed for containing the trench drain system.
 - 1) Provide either a rebar clip system consisting of rebar clips on each side of the modular channel sections and designed to receive rebar "stakes" to support and level the trench drain assembly, or another system with similar capabilities.
 - c. Provide appropriate hardware to connect the frame assembly and modular channel sections together.
2. Modular Channel Sections:
 - a. Provide 6-inch wide modular channel sections with 4-inch throats fabricated from fiber reinforced polyester (FRP) fiberglass, and designed with interlocking ends that mate with adjoining sections.
 - b. Provide modular channel sections having sloped bottoms to promote fluid flow along the length of the section.
3. End Caps:
 - a. Provide end caps designed to fit the ends of the modular channel sections, cut to the appropriate height.
4. Outlets:
 - a. Provide end outlets designed to fit the ends of the modular channel sections, cut to the appropriate height, and having outlet diameters sized to fit with the mating drain piping.
 - b. Provide bottom outlets designed to fit the contours of the bottom of the modular channel sections, and having outlet diameters sized to fit with the mating drain piping.

5. Grates:

- a. Provide ductile iron slotted drain grates with mechanical lockdown devices.
- b. Open Area: 28.1 square inches minimum per foot of grating length.
- c. Slot Width: 0.50 inch.



2.02 ACCESSORIES

- A. Caulk/Adhesive:
 - 1. Provide silicon caulk or construction adhesive.
- B. Concrete:
 - 1. Provide concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete.
- C. Ductile Iron Pipe (DIP) and Fittings:
 - 1. Provide Class 50 ductile iron pipe (DIP) and fitting materials designed in accordance with the requirements of AWWA C151/A21.51.
 - a. Provide ductile iron pipe manufactured in accordance with the requirements of AWWA C151/A21.51.
 - b. Joints:
 - 1) Provide mechanical joints for ductile iron pipe complying with the requirements of AWWA C111/A21.11.
 - 2) Provide cast iron glands, synthetic rubber gaskets, and T-head bolts and nuts for the joints.
 - c. Fittings:
 - 1) Provide either gray-iron or ductile iron fittings complying with the requirements of either AWWA C110/A21.10 or AWWA C153/A21.53, and having mechanical joint ends.
 - a) Provide fittings complying with the requirements of AWWA C111/A21.11.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine trench drain block-outs in concrete or trench excavations to verify that the depth of each is a minimum of 4 inches greater than the depth of the trench drain's modular channel sections, and a minimum width of 14 inches.
- B. Evaluation and Assessment:
 - 1. Do not proceed with installation of the trench drains where the block-out in concrete or trench excavation depths are less than those required by the manufacturer for the applications indicated.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the utility trench drains.
- B. Surface Preparation:
 - 1. Construct a block-out in concrete slabs or a trench in earth for containing the trench drain system.



- a. Ensure that the soil substrate where the trench drain is to be installed is not soft or shifting.

3.03 INSTALLATION

A. Modular Channel Sections:

1. Layout the modular channel sections so the individual units are in their correct locations and sequence according to the approved Shop Drawings, and their slopes are aligned to facilitate flow in the proper direction.
2. Align the mating ends of adjacent channel sections, apply caulk/adhesive to the joints as a sealer, and join the sections together.

B. Frame:

1. Attach the frame assembly to the modular channel sections using the appropriate hardware.

C. End Caps and End Outlets:

1. Prior to suspending the frame/modular channel section assembly within the block-out or open trench, attach end cap or end outlet to the end of the appropriate channel section.
 - a. If necessary, remove the male overlap portion on the end of the mating channel section, and cut the end cap or end outlet to the proper height.
 - b. Apply caulk/adhesive to the joint, and join the mating components together.
2. Attach the end cap or end outlet to the frame using an appropriate bracket and/or other hardware.

D. Bottom Outlets:

1. Prior to suspending the frame/modular channel section assembly within the block-out or open trench, attach the bottom outlet to the correct channel section at the appropriate location using caulk/adhesive.
2. Use a hole saw of the proper size to cut a round hole through the bottom of the channel section.

E. Suspending the Frame/Modular Channel Section Assembly:

1. Suspend the frame/modular channel section assembly within the block-out or open trench using an appropriate method recommended by the trench drain system's manufacturer.
 - a. Submit the method(s) for suspending the assemblies recommended by the trench drain system's manufacturer to the Program/Project Manager for information.
 - b. If the trench drain system manufacturer has no recommended method, suspend the assembly from temporary lumber spanning the top of the concrete block-out or excavated trench width.
 - c. If the trench drain is being installed in excavated trenches with rebar clips, drive the rebar provided for the clips into the ground to positively anchor the system in place.

F. Placing and Finishing Concrete:



1. Pour concrete around the 3 sides of the trench drain, being sure to properly vibrate the concrete as it is being placed to eliminate unwanted voids.
 2. Finish trowel the concrete to set the top edge of the trench drain approximately 1/16 inch below finish grade, being sure to compensate for concrete shrinkage during curing.
- G. Installing Grates:
1. After the concrete has been placed, vibrated, and cured, install the grates.
- H. Installing Storm Drain Pipe:
1. Install storm drain pipe and fittings as shown on the Contract Drawings in accordance with the manufacturer's written instructions.
 2. Joints for Ductile Iron Storm Drain Pipe:
 - a. Assemble storm drain pipe joints in accordance with the manufacturer's installation instructions and indicated reference standards.

3.04 CLEANING

- A. Waste Management:
1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	12/19/2018		2.01.A.2.a. 2.01.E.5.a, b, c.	Revised per RFI-0736





SECTION 02702

CONCRETE CURB, GUTTER, DRIVEWAY, SIDEWALK, AND ALLEY ENTRANCE

PART 1 GENERAL

RFI
1209

Forms for Curb & Gutter and Sidewalk

It is acceptable to use standard lumber sizes
as formwork for curb, gutter, and sidewalks.

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for various types of concrete curb, gutter, sidewalk, sidewalk ramps, driveways, and alley intersections.
 - 2. Requirements for contraction joints and expansion joints in concrete curb, gutter, sidewalk, sidewalk ramps, driveways, and alley intersections.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 02339 - Subgrade Preparation.
 - 4. Section 03100 - Concrete Forms and Accessories.
 - 5. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Concrete Institute (ACI):
 - 1. ACI 305R - Hot Weather Concreting.
 - 2. ACI 306R - Cold Weather Concreting.
- B. Arizona Department of Transportation (ADOT):
 - 1. ADOT Standard Specifications for Road and Bridge Construction.
 - 2. Arizona Stored Specifications:
 - 3. ADOT Standard Drawings – Construction Standards.
- C. ASTM International (ASTM):
 - 1. ASTM D 1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 2. ASTM D 1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Filler for Concrete Paving and Structural Construction.
 - 3. ASTM D 2628 – Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
- D. City of Phoenix (COP):
 - 1. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - a. Section 725 - Portland Concrete Cement.
 - 2. Phoenix Supplemental Standard Details for Public Works:



- a. Detail No. P1016 Right Turn Lane Design for Public Cross Streets.
- b. Detail No. P1016-1 Right Turn Lane Design for Driveways.
- c. Detail No. P1164 Maximum Driveways & Alleys Slope.
- d. Detail No. P1230 Sidewalks.
- e. Detail No. P1231 Apron Joints.
- f. Detail No. P1235 Sidewalk Ramp Detail – Type “C”.
- g. Detail No. P1235-1 Sidewalk Ramp Detail (Type C Modified) (Detached Sidewalk).
- h. Detail No. P1236 Mid-Block Ramp with 4” Roll Curb.
- i. Detail No. P1237 Apron Joints.
- j. Detail No. P1238 Sidewalk Ramp Detail – 25’ or 30’ Radius Curb Return.
- k. Detail No. P1240 Sidewalk Ramp Detail – 35’ Radius Curb Return.
- l. Detail No. P1241 Sidewalk Ramp Detail – 20’ Radius Curb Return.
- m. Detail No. P1241-1 Sidewalk Ramp Detail – 20’ Radius Curb Return.
- n. Detail No. P1241-2 Sidewalk Ramp Detail – with Limited R/W.
- o. Detail No. P1241-3 Single Sidewalk Ramp Detail – 20’ Radius Curb Return.
- p. Detail No. P1242 Sidewalk Ramp Detail – 4” Vertical Curb Return.
- q. Detail No. P1243 Return Type Driveways with Attached Sidewalk.
- r. Detail No. P1243-1 No Right Turn Lane.
- s. Detail No. P1243-2 Right Turn Lane.
- t. Detail No. P1244 Driveway-Pedestrian Ramp Combination (for Use at T Type Intersections).
- u. Detail No. P1255-1 Driveway Entrance - Type I (Sidewalk Adjacent to Curb).
- v. Detail No. P1255-2 Driveway Entrance - Type II (Detached Sidewalk).
- w. Detail No. P1255-3 Driveway Entrance – ADA Retrofit.
- x. Detail No. P1255-3 Driveway Widths Policy.

E. Maricopa Association of Governments (MAG):

- 1. Uniform Standard Specifications for Public Works Construction:
 - a. Section 725 - Portland Concrete Cement.
 - b. Section 729 - Expansion Joint Filler.
- 2. Uniform Standard Details for Public Works Construction.
 - a. Detail No. 202 Alley details (Paved and Unpaved).
 - b. Detail No. 203 Scuppers.
 - c. Detail No. 206-1 Concrete Scupper.
 - d. Detail No. 206-2 Concrete Scupper.



- e. Detail No. 210 Residential Speed Hump.
- f. Detail No. 220 Curb and Gutter Types A, B, and C.
- g. Detail No. 221 Curb and Gutter (Transition, Integral & Warning Beacon.
- h. Detail No. 222 Single Curb - Types A, B, and Termination.
- i. Detail No. 223 Median Nose Transition.
- j. Detail No. 224 Joint for Drainage inlets and Manhole Covers.
- k. Detail No. 230 Sidewalks.
- l. Detail No. 231 Sidewalk Ramps – Type ‘A’.
- m. Detail No. 232 Sidewalk Ramps – Type ‘B’.
- n. Detail No. 233 Sidewalk Ramps – Type ‘C’.
- o. Detail No. 234 Sidewalk Ramps – Type ‘D’.
- p. Detail No. 240 Valley Gutter.
- q. Detail No. 250 Driveway Entrances.
- r. Detail No. 250 Return Type Driveways.
- s. Detail No. 260 Alley Entrance (with Combined Curb and Gutter).
- t. Detail No. 261 Alley Entrance (with Roll Type Curb and Gutter).
- u. Detail No. 262 Wing Type Alley Entrance (with Combined Curb and Gutter).
- v. Detail No. 263 Wing Type Alley Entrance (with Roll Type Curb and Gutter).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Depending on where the curb, gutter, sidewalk, sidewalk ramp, driveway, or alley entrance construction is to occur and the owner of the right-of- way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport.
2. Adhere to each owner’s specifications and/or permits, and comply with additional requirements of the owners, regarding the Work of this Section.
3. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.

B. Sequencing:

1. Include provisions for traffic control during concreting operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the curbs, gutters, sidewalks, sidewalk ramps, driveways, and alley entrances from traffic for a minimum of 7 Days after concrete placement.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Concrete.
 - 2) Expansion joint filler.
 - b. Shop Drawings:
 - 1) Working Drawings for the curb, gutters, sidewalks, sidewalk ramps, driveways, and alley entrances.
 - c. Certificates:
 - 1) Certificates of Compliance for expansion joint filler.
 - d. Special Procedure Submittals:
 - 1) Manufacturer's data for machinery used in lieu of conventional concrete forms.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Required approvals depend on who owns the right-of- way and where the curb, gutter, sidewalk, sidewalk ramp, driveway, or alley entrance is to be constructed, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport Design and Construction Services.
2. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, that information will be provided on the Contract Drawings.

B. Certifications:

1. Submit Certificates of Compliance for expansion joint filler that include the following information:
 - a. Description of material supplied.
 - b. Quantity represented by the Certificate.
 - c. A means of identifying the material, such as a label, lot number, or marking.
 - d. A statement certifying the material complies with the requirements of specifications cited.
 - e. The name, title and signature of a person having the authority to bind the manufacturer or Supplier of the material.



1.06 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Cold Weather Concreting:
 - a. Perform cold weather concrete work in accordance with the requirements of ACI 306R.
 - 2. Hot Weather Concreting:
 - a. Perform hot weather concrete work in accordance with the requirements of ACI 305R and the following additional requirements:
 - 1) Do not deliver concrete having a temperature exceeding 90 degrees Fahrenheit to the Work Site.
 - 2) Cool the mix's ingredients before mixing to prevent the temperature of the mix from exceeding 90 degrees Fahrenheit.
 - 3) Furnish windbreaks, shading, fog spraying, sprinkling, or wet covering when necessary.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete:
 - 1. Provide concrete complying with the requirements for Class B concrete as specified in Section 03300, Cast-In-Place Concrete.
- B. Expansion Joint Filler:
 - 1. Provide expansion joint filler complying with the requirements specified in MAG Section 729 and ASTM D 1751, ASTM D 1752, or ASTM D 2628.
- C. Design Criteria:
 - 1. Submit Product Data for the proposed materials to the Program/Project Manager for approval.
 - 2. Submit Working Drawings for the curb, gutters, sidewalks, sidewalk ramps, driveways, and alley entrances to the Program/Project Manager for approval.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Inspect the locations intended to receive cast-in-place concrete for deficiencies which would prevent proper execution of the concrete work.
- B. Evaluation and Assessment:
 - 1. Do not proceed with concrete placement until deficiencies discovered by the inspection are corrected to the satisfaction of the Program/Project Manager.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not place excavated material where it will interfere with access to property or traffic flow in the street.
- B. Surface Preparation:
 - 1. Do not place material displaced by the construction on the base and/or surfacing material already in place on adjacent roadways.
 - 2. Construct and compact the subgrade true to grades and lines shown on the Plans and as specified in Section 02339.
 - a. Remove all soft or unsuitable material to a depth not less than 6 inches below subgrade elevation and replace it with Material acceptable to the Program/Project Manager.
 - b. When the Program/Project Manager determines that the existing subgrade consists of soils with swelling characteristics, bring the moisture content as close as possible to the optimum required for compaction.
 - 1) Obtain optimum moisture content by the addition of water, by the addition and blending of dry suitable material, or by drying the existing material.
 - c. Compact the subgrade to a relative density of 90 percent minimum.
- C. Demolition/Removal:
 - 1. Cut existing pavements and concrete joined to new construction.
 - a. Smoothly saw cut concrete to neat, straight, vertical, true lines so the adjoining surface will not be damaged.
 - 1) The minimum depth of cut is 1-1/2 inches or 1/4 of the thickness (D/4), whichever is greater.
 - 2) Clean-cut asphalt concrete only with approved equipment and methods
 - a) Paint trimmed edges with a light coating of asphalt cement or emulsified asphalt immediately prior to constructing the new abutting asphalt concrete.
 - 3) Do not rip or root outside the limits of cuts.
 - b. Remove existing concrete sidewalks and driveways that abut the new sidewalks and driveway entrances to a distance required to maintain slope as indicated in MAG Standard Details or not to exceed 1-inch per foot where sidewalks are concerned.
 - c. Saw cutting is required at the match lines.

3.03 INSTALLATION

- A. Construct concrete curb, gutter, sidewalk, sidewalk ramps, driveways, and alley intersections to the dimensions indicated on the Contract Drawings and MAG Standard Details.



B. Concrete Formwork:

1. Furnish conventional concrete forms as specified in Section 03100, Concrete Forms and Accessories, unless otherwise approved.
 - a. Carefully set forms that conform to the dimensions of the curb, gutter, sidewalk, sidewalk ramp, driveway, or alley entrance to line and grade, and securely stake them into position.
 - b. Water the forms and subgrade immediately in advance of placing concrete.
 - c. Clean forms thoroughly each time they are used.
 - d. Coat forms with a light oil or other releasing agent which does not discolor the concrete.
2. Construct concrete curbs and gutters by using conventional concrete forms, or when approved by the Program/Project Manager by means of an appropriate machine.
 - a. If applicable, submit the manufacturer's data for machinery used in lieu of conventional forms to the Program/Project Manager for approval of the equipment.
3. All construction requirements applicable to the use of conventional forms also apply to the use of the machines.
 - a. If machines approved by the Program/Project Manager and specifically designed for such Work are used, the results must be equal to or better than those produced by the use of conventional forms.
 - b. If the results are unsatisfactory to the Program/Project Manager, discontinue using the machines and make necessary repairs at no increase in Contract Price.

C. Placing Concrete:

1. Place the concrete in the forms.
2. Spade concrete away from the forms so there will be no rock pockets next to the forms.
3. Compact concrete using mechanical vibrators approved by the Program/Project Manager.
4. Continue tamping or vibrating the concrete until mortar flushes to the surface, and the coarse aggregate is below the concrete surface.

D. Finishing and Curing Concrete:

1. Finish and cure the concrete as specified in Section 03300.

E. Expansion Joints:

1. Unless otherwise specified or shown, construct expansion joints in accordance with the City of Phoenix Standard Detail P1230.
2. Construct expansion joints in a straight line and vertical plane perpendicular to the longitudinal line of the sidewalk, curb, or gutter except, in the case of a curved alignment, construct expansion joints along radial lines of the curve.



3. Construct expansion joints to the full depth and width of the concrete, and match the joints in the adjacent pavement, sidewalk, curb, or gutter.
4. Extend the expansion joint material through the concrete from the surface to one inch into the subgrade.
5. Construct expansion joints at all radius points, driveways, alley entrances, and at adjoining structures.
 - a. Construct expansion joints with a maximum interval of 100 feet between joints.

F. Contraction Joints:

1. Unless otherwise specified, construct contraction joints in accordance with City of Phoenix Standard Detail P1230.
2. Construct contraction joints in a straight line and vertical plane perpendicular to the longitudinal line of the sidewalk, curb, or gutter, except, in the case of a curved alignment, construct contraction joints along radial lines of the curve.
3. Construct contraction joints to a depth of 1-1/2 inches at 10 foot intervals on all sidewalks regardless of the width.
4. Unless an expansion joint is required, construct contraction joints to coincide with each form joint.
5. Provide sidewalk score marks at least 1/2 inch deep at the mid-point of the contraction joint.

G. Edges:

1. Shape all edges with a suitable tool formed to round the edges to a radius as indicated on the MAG Standard Details.

H. Identification:

1. Stamp the Contractor's name and the year the Work is performed on all Work done by the Contractor.
2. Locate this information on each end of the curb, gutter, sidewalk, or sidewalk ramp with letters not less than 3/4 inch in height.

I. Formwork Removal:

1. Exercise care to prevent damage when removing concrete forms.
2. Do not remove the front face form before the concrete has taken initial set and has sufficient strength to carry its own weight.
3. Do not remove gutter forms and rear forms until the concrete has hardened sufficiently to prevent damage to the edges.

J. Backfilling:

1. Unless otherwise specified, backfill behind the curbs, sidewalk, or sidewalk ramps with soil native to the area and to the lines and grades shown on the Contract Drawings.

K. Tolerances:



1. Curb and Gutter: 1/4 inch when measured with a 10 foot straight edge.
2. Sidewalk and Sidewalk Ramps: 1/8 inch when measured with a 5 foot straight edge.

3.04 REPAIR

- A. Repair any portion of concrete damaged while stripping forms; or if the damage is severe, replace the concrete at no additional increase in Contract Price.
- B. Remove and replace any section of the Work deficient in depth or not conforming to the Contract Drawings or Specifications at no additional increase in Contract Price.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Curb and Gutter Tolerance Test:
 - a. Test Procedure:
 - 1) With a 10-foot straight edge or curve template, check the face, top, back, and flow line of the curbs and gutters will be checked longitudinally along the surface to verify they are constructed as indicated on the Contract Drawings within the allowable tolerances.
 - b. Acceptance Criteria:
 - 1) Curbs and gutters having deviations within the specified allowable tolerance are acceptable.
 2. Sidewalk and Sidewalk Ramp Tolerance Test:
 - a. Test Procedure:
 - 1) With a 5-foot straight edge, the sidewalks and sidewalk ramps will be checked to verify they are constructed as indicated on the Contract Drawings within the allowable tolerances.
 - b. Acceptance Criteria:
 - 1) Sidewalks and sidewalk ramps having deviations within the specified allowable tolerance are acceptable.
 3. Gutter Drainage Test:
 - a. Test Procedure:
 - 1) Gutters that have a slope of 0.8 foot per hundred feet or less and gutters having unusual or special conditions that cast doubt on the capability of the gutters to drain may be tested by applying water from a hydrant, tank truck or other source to establish the flow in the length of gutter to be tested.
 - 2) 1 hour after the supply of water is shut off, the gutter will be inspected for evidence of ponding or improper shape.
 - b. Acceptance Criteria:



- 1) Ponded water in the gutter or on adjacent asphalt pavement to a depth of more than 1/2 inch is unacceptable.

B. Non-Conforming Work

1. Correct any deviations in curbs, gutters, sidewalks, and sidewalk ramps in excess of the specified allowable tolerances at no increase in Contract Price.
2. If water is found ponded in gutters or on adjacent asphalt pavement to a depth of more than 1/2 inch, correct the defect or defects in a manner acceptable to the Program/Project Manager at no increase in contract Price.

3.06 WASTE MANAGEMENT:

- A. Haul demolished surface materials away from the Site as soon as practical, and do not use them as backfill.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 02721

AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for untreated base, such as select material or aggregate base course, to be place on prepared surfaces to distribute wheel loads and provide material on which to support surface courses.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 02339 - Subgrade Preparation.
 - 4. Section 02741 - Bituminous Concrete Pavement.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. FAA: Federal Aviation Administration.
- B. Definitions:
 - 1. Fine Aggregate: Fines produced by the crushing operation performed on coarse aggregate which pass the Number 4 sieve.
- C. Reference Standards:
 - 1. American Association of State Highway Transportation Officials (AASHTO):
 - a. AASHTO T 89 - Standard Method of Test for Determining the Liquid Limit of Soils.
 - b. AASHTO T 90 - Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
 - c. AASHTO T 146 - Standard Method of Test for Wet Preparation of Disturbed Soil Samples for Test.
 - 2. ASTM International (ASTM):
 - a. ASTM C 88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - b. ASTM C 117 - Standard Test Method for Materials Finer than 75- μ m (No.200) sieve in Mineral Aggregates by Washing.
 - c. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - d. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.



- e. ASTM D 75 – Standard Practice for Sampling Aggregates.
- f. ASTM D 448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
- g. ASTM D 693 – Standard Specification for Crushed Aggregate for Macadam Pavements.
- h. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- i. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- j. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by Rubber Balloon Method.
- k. ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- l. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- m. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- n. ASTM D 3665 - Standard Practice for Random Sampling of Construction Materials.
- o. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- 3. Maricopa Association of Governments (MAG).
 - a. Uniform Standard Specifications for Public Works Construction:
 - 1) Section 330 - Asphalt Chip Seal.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Except when materials will be provided from a previously approved source, notify the Program/Project Manager of the source of aggregate in writing at least 10 Days in advance of delivering the material to allow sufficient time for required material acceptance testing.
- B. Sequencing:
 - 1. Prior to placing aggregate base course materials, properly prepare the subgrade in accordance with Section 02339, Subgrade Preparation.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Aggregate base course material.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport aggregate base in suitable vehicles with covers to prevent stray particles from falling off the vehicles onto the streets.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Aggregate:
 - 1. Provide crushed aggregate complying with the requirements specified herein unless the use of a different type of material is specifically authorized on the Contract Drawings.
 - a. Crushed Aggregate:
 - 1) Provide clean, hard, sound, and durable crushed stone, rock, or gravel or a combination thereof; and which has the following additional properties:
 - a) Gradation (Job Mix):
 - (1) Provide continuously and well graded crushed aggregate when tested in accordance with ASTM C 117 and ASTM C 136, and having the gradation indicated in Table 02721-1.

Table 02721-1 Crushed Aggregate Gradation
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Sieve Sizes (Square Openings)	Design Range Percentage by Weight Passing Sieve				
	Select Material		Aggregate Base		Tolerance (Percent) ⁽¹⁾
	Type A	Type B	Type C	Type D	
3 inches	100	-	-	-	-
2 inches	-	-	-	100	0
1-1/2 inches	-	100	-	95-100	±5
1-1/4 inches	-	-	100	-	-
1 inch	-	-	-	70-95	±8
3/4 inch	-	-	-	55-85	±8
Number 4	30-75	30-70	38-65	30-60	±8
Number 8	20-60	20-60	25-60	-	-
Number 30	10-40	10-40	10-40	12-30	±5
Number 200	0-12	0-12	3-12	0-8	±3
1. The job mix tolerance listed in Table 02721-1 applies only to Type D aggregate base, and when applied to a job mix gradation establishes a job control grading band. If application of the tolerance results in a job control grading band outside the design range, the full tolerance still applies; however, the job mix range must be capable of being tested in accordance with the requirements specified in ASTM D 1556 and ASTM D 1557.					

- 2) Type A, Type B, and Type C Crushed Aggregate:
- Provide crushed aggregate uniform in quality, and free of soft, friable, thin elongated, or laminated pieces; disintegrated material; organic material; oil, alkali, and other deleterious substances.
 - Special Gradation Requirements:
 - When crushed rock is required, provide material with at least one rough, angular surface produced by crushing; and a gradation complying with the requirements of ASTM D 448.
 - For sizes 3/4 inch or larger maximum sizes, the portion of the material retained on a No. 4 sieve must be 50 percent by weight.
 - For sizes less than 3/4 inch, the portion of the material retained on a No. 8 sieve must be 50 percent by weight.



- (2) When gravel is required, provide material having particles that are fully or partially rounded and water-worn.
 - (a) Crushed rock obtained by crushing rock which exceeds the maximum gradation sizes specified in ASTM D 448 may be combined with gravel provided it is uniformly distributed throughout and blended with the gravel.
- c) Plasticity Index:
 - (1) Unless otherwise indicated, provide material having a plasticity index not more than 5 when tested in accordance with the requirements of AASHTO T 146 Method A (Wet Preparation), AASHTO T 89, and AASHTO T 90.
- d) Soundness:
 - (1) Provide crushed aggregate having a percentage of wear not exceeding 40 after 500 revolutions in the Los Angeles abrasion machine as determined in accordance with Grading B as specified in ASTM C 131.
- 3) Type D Crushed Aggregate (FAA P-209):
 - a) Provide crushed aggregate free from coatings of clay, silt, vegetable matter, and other objectionable materials; and containing no clay balls.
 - b) Special Gradation Requirements:
 - (1) Provide crushed aggregate continuously well graded from coarse to fine that does not vary from the low limit on one sieve to the high limit on an adjacent sieve or vice versa.
 - (2) If necessary, fine aggregate, defined as fines produced by the crushing operation performed on coarse aggregate and passing the Number 4 sieve, may be added to produce the correct gradation.
 - (a) Produce the fine aggregate by crushing stone or gravel complying with the wear and soundness requirements specified for coarse aggregate.
 - (3) The portion of the material retained on a No. 4 sieve must not contain more than 15 percent by weight of flat or elongated particles as defined in ASTM D 693; and must contain at least 90 percent by weight of particles having at least 2 fractured faces and 100 percent having at least 1 fractured face.
 - (a) The area of each face must be equal to at least 75 percent of the smallest mid-sectional area of the piece.
 - (b) If 2 fractured faces are contiguous, the angle between the planes of the fractures must be at least 30 degrees to count as 2 fractured faces.



- (4) 70 percent passing the 3/4 inch sieve is the limit of the design and job mixes.
- (5) The fraction of the final mixture that passes the Number 200 sieve may not exceed 60 percent of the fraction passing the Number 30 sieve.
- (6) Uniformly blend and mix aggregate during crushing operations or mixing in a plant to comply with specified requirements and secure the proper mixture content for compaction.
- c) Liquid Limit:
 - (1) Provide material so the liquid limit of the fraction passing the Number 40 sieve is no greater than 25 when tested in accordance with the requirements specified in ASTM D 4318.
- d) Plasticity Index:
 - (1) Provide material having a plasticity index not more than 4 when tested in accordance with the requirements specified in ASTM D 4318.
- e) Sand Equivalent Value:
 - (1) Provide material so the fine aggregate has a minimum sand equivalent value of 35 when tested in accordance with the requirements specified in ASTM D 2419.
- f) Soundness:
 - (1) Provide crushed aggregate having a percentage of wear not exceeding 45 as determined in accordance with the procedures specified in ASTM C 131.
 - (2) Provide crushed aggregate having sodium sulfate soundness loss after 5 cycles not exceeding 12 percent as determined in accordance with the procedures specified ASTM C 88.
- b. Processed Natural Material:
 - 1) Provide processed natural material consisting of hard, durable fragments of stone or gravel and a filler of sand or other finely divided matter; free of an excess of soft or disintegrating pieces, alkali, adobe, vegetable matter, loam, or other deleterious substances; and has the following additional properties:
 - a) Gradation:
 - (1) Provide processed natural material having the gradation indicated in Table 02721-1 except that the least dimension of the maximum particle size cannot exceed 2/3 of the compacted thickness of the specified lift being placed.
 - b) Soundness:
 - (1) Provide processed natural material having a percentage of wear not exceeding 40 after 500 revolutions in the Los



Angeles abrasion machine as determined in accordance with Grading B as specified in ASTM C 131.

- c) Plasticity Index:
 - (1) Unless otherwise indicated, provide material having a plasticity index not more than 5 when tested in accordance with the requirements of AASHTO T 146 Method A (Wet Preparation), AASHTO T 89, and AASHTO T 90.
- d) Liquid Limit:
 - (1) Provide processed natural material having a liquid limit not exceeding 25 percent when tested in accordance with AASHTO T 89.
- c. Decomposed Granite:
 - 1) Provide decomposed granite consisting principally of quartz and feldspar granitoid igneous rock which has been weathered in place and fragments of granitic rock not yet broken down into the component minerals.
 - a) Provide decomposed granite which will remain stable when saturated with water.
 - b) Gradation:
 - (1) Do not use particles larger than 3 inches which will not be broken in the rolling and tamping process.
 - (2) Provide decomposed granite such that no more than 20 percent will pass the number 200 mesh sieve when subjected to the Decomposed Granite Gradation Test specified in Subparagraph 2.03.A.3.
 - c) Plasticity Index:
 - (1) The material passing the number 200 mesh sieve from the gradation test must have a plasticity index not less than 3 or more than 10 when determined in accordance with the requirements of AASHTO T 146 Method A (Wet Preparation), AASHTO T 89, and AASHTO T 90.
- 2. Submit Product Data for the aggregate material to the Program/Project Manager for approval.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Prior to the start of production, at the start of production, and at intervals during production, submit Samples of each material for preliminary testing to the City of Phoenix Materials Laboratory for testing and as the basis for approval of specific lots of aggregates.
 - a. The Program/Project Manager will determine the sampling points and intervals.



2. In lieu of material testing, the Program/Project Manager may accept certified test results from the State that indicate the aggregate complies with the specified requirements.
3. Decomposed Granite Gradation Test:
 - a. Test Procedure:
 - 1) A sample quantity of decomposed granite sufficient to have a dry weight of 15 pounds after being dried at a temperature between 215 degrees Fahrenheit and 230 degrees Fahrenheit to a constant weight will be selected and dried.
 - 2) 15 pounds of the dried decomposed granite and nothing else will be placed in a Los Angeles abrasion machine and subjected to 500 revolutions in accordance the requirements specified for Grading B in ASTM C 131.
 - 3) The percentage of material passing through a Number 200 mesh sieve by washing will be determined in accordance with the procedure specified in ASTM C 117.
 - b. Acceptance Criteria:
 - 1) Decomposed granite samples that do not pass more than 20 percent of their material through the Number 200 mesh sieve will pass the Decomposed Granite Gradation Test.
- B. Non-Conforming Work
 1. Correct deficiencies uncovered by the measurements or Samples.
- C. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when aggregate base for this Contract is being placed and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the subgrade has been properly prepared to receive the aggregate base course.

3.02 PREPARATION

- A. Surface Preparation:
 1. Prepare the subgrade as specified in Section 02339, Subgrade Preparation.



2. Correct ruts and soft yielding places caused by improper drainage conditions, hauling, or other causes before placing the base course.

3.03 INSTALLATION

- A. Place base course material in lifts to provide a course to the lines, grades, dimensions, moisture, density, and typical sections as indicated in the Contract Documents.
 1. Aggregate base course measuring 6 inches or less in compacted thickness may be placed in a single layer.
 2. Deliver the aggregate to the roadbed as a uniform mixture, and spread the aggregate in one operation.
 3. Avoid segregation of the material into pockets of fine and coarse material.
 4. Place Type D aggregate on moistened subgrade in layers of uniform thickness not more than 6 inches deep using a mechanical spreader.
 - a. Do not place aggregate on frozen subgrade.
- B. Aggregate base course measuring more than 6 inches in compacted thickness must be built up from successive layers, each of approximately equal compacted thickness not to exceed 6 inches per layer.
 1. Clean previously constructed layers of loose and foreign material prior to placing the next layer.
- C. After distributing the aggregate base course, water the material and, immediately thereafter, blade the material to a uniform layer that will net the required thickness after compaction.
 1. Apply a quantity of water that will assist compaction, taking care to avoid wetting the subgrade or any lower base course during the watering operation to an extent that is detrimental to the Work.
 - a. Moisture condition the material within the range of plus or minus 2 percent of optimum moisture, and compact the material to a dry density greater than 95 percent of maximum dry density as determined in accordance with the requirements of ASTM D 1557.
 2. Keep the surfaces of the compacted material in lower layers moist until the material is covered by the next layer.
 3. If the materials deposited are not uniformly blended together, continue the blading operation as necessary to eliminate segregation.
- D. Compact the material to assure a compacted relative density of 100 percent as determined using the methods and other criteria defined in Section 02339, Subgrade Preparation.
- E. Upon completion of the entire operation, the base surface must be true, even, uniform, and conform to the grade and cross-section specified or shown on the Contract Drawings.



1. Finish the base course by blading the surface of the aggregate base course using equipment designed especially for this purpose.

F. Tolerances:

1. Finished Surface Tolerance:

- a. The finished surface of the aggregate base course may not vary more than 1/2 inch above or below required grade and cross-section when tested with a 16-foot straightedge applied parallel with and at right angles to the centerline.

- 1) Do not add thin layers of material to the top layer of base course to meet the specified grade.

- a) If the elevation of the top layer is 1/2 inch or more below grade, scarify the top layer of the base to a depth at least 3 inches, add new material, and blend and re-compact the material to bring it to grade.

- 2) If the finished surface is above the design grade, cut the material back to grade and re-roll the surface.

2. Thickness Tolerance:

- a. The completed thickness of the aggregate base course may not vary more than 1/2 inch of the design thickness.

3. Moisture Content Tolerance:

- a. During placing operations, the moisture content of the material may not vary by more than 1-1/2 percentage points from the optimum moisture content as determined in accordance with the requirements specified in ASTM D 1557.

3.04 RESTORATION

- A. Restore to their original condition those portions of the Site not designated for alteration.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when aggregate base is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.



- c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- 2. Gradation Test:
 - a. Test Procedure:
 - 1) Gradation Tests will be performed by the Testing and Inspection Agency on samples taken from material delivered to the Site at a rate of 1 test for each 300 tons placed, or once a day, whichever is greater.
 - a) Sampling will be performed in accordance with the requirements specified in ASTM D 75.
 - b) Testing will be performed in accordance with the requirements specified in ASTM C 117 and ASTM C 136.
 - b. Acceptance Criteria:
 - 1) The average value of individual gradation tests for all sieve size determinations must comply with the specified gradations within plus or minus 8 percent for sieves larger than No. 4, within plus or minus 5 percent for sieves No. 30, and within plus or minus 3 percent for sieves No. 200.
- 3. Moisture Density Test:
 - a. Test Procedure:
 - 1) Moisture Density Tests will be performed by the Testing and Inspection Agency on samples taken from material delivered to the Site at a rate of 1 test for each 300 tons placed, or once a day, whichever is greater.
 - b. Acceptance Criteria:
 - 1) Material represented by the samples will be acceptable if the compaction meets the specified moisture density criteria.
- 4. Compaction Test for Other Materials than Type D Crushed Aggregate:
 - a. Test Procedure:
 - 1) Compaction Tests will be performed by the Testing and Inspection Agency at a rate of 1 test for each 500 square yards per lift placed.
 - 2) Testing will be performed as specified in ASTM D 2922 and ASTM D 3017
 - b. Acceptance Criteria:
 - 1) Areas represented by the tests will be acceptable if the compaction meets the specified compaction criteria.
- 5. Compaction Test for Type D Crushed Aggregate:
 - a. Either Test Procedure 1 or Test Procedure 2 specified herein below may be used to determine the compaction of Type D crushed aggregate.



- 1) If Test Method 2 is to be used, at least 1 in 4 of the tests must be performed in accordance with Test Method 1 in order to correlate the test results.
 - a) Calibration tests will be conducted on each lot of material placed that complies with the specified density requirements.
 - 2) Aggregate base course testing will be performed on a lot basis.
 - a) A lot consists of one day's production if is not expected to exceed 2400 yards.
 - b) A lot consists of one-half day's production if is expected to include 2400 yards or more.
 - c) Each lot includes 2 equal sublots.
 - 3) One test will be performed for each subplot on material specimens sampled from locations randomly selected by the Program/Project Manager in accordance with the statistical procedures specified in ASTM D 3665.
- b. Test Procedure 1:
- 1) The specimens will be compacted and laboratory tested in accordance with the procedures specified in ASTM D 1557.
 - 2) The in-place field density will be determined in accordance with the procedures specified in ASTM D 1556 or ASTM D 2167.
 - 3) If the specified density is not attained, the entire lot must be reworked and/or re-compacted, and 2 additional tests on randomly selected samples from the lot will be performed.
 - a) Continue this procedure until the specified density is attained.
- c. Acceptance Criteria for Test Procedure 1:
- 1) Aggregate base course acceptance will be on a lot basis.
 - 2) If the field density is at least 100 percent of the maximum density of laboratory specimens prepared from samples of base course material delivered to the Site, the subplot represented by that sample will pass the Compaction Test for Type D Crushed Aggregate.
- d. Test Procedure 2:
- 1) The specimens will be tested using a nuclear gage in accordance with the procedures specified in ASTM D 2922.
 - a) The nuclear gage will be field calibrated in accordance with the paragraph 4 in ASTM D 2922.
 - b) Calibration tests will be conducted on the first lot of material placed that complies with the specified density requirements.
 - 2) Because the procedures specified in ASTM D 2922 result in a wet unit weight, the procedures specified in ASTM D 3017 will be used to determine the moisture content of the material.
 - a) The calibration curve furnished with the moisture gages will be checked as specified in paragraph 7 in ASTM D 3017.



- b) Calibration verifications of both density and moisture gages will be performed at the beginning of the base course Work, and at intervals determined by the Program/Project Manager.
 - e. Acceptance Criteria for Test Procedure 2:
 - 1) Aggregate base course acceptance will be on a lot basis.
 - 2) If the field density is at least 100 percent of the maximum density of laboratory specimens prepared from samples of base course material delivered to the Site, the subplot represented by that sample will pass the Compaction Test for Type D Crushed Aggregate.
 - 6. Inspections:
 - a. If the Program/Project Manager believes that a deficiency in thickness, or an excess of plasticity exists, take measurements or samples in the same pattern as that defined in Section 02741, Bituminous Concrete Pavement, except for Type D aggregate base material.
 - 1) For Type D aggregate base material, 4 thickness determinations will be made for each lot by dividing the lot into 4 equal sublots and performing 1 test on each of these sublots at random locations determined by the Program/Project Manager in accordance with the statistical procedures specified in ASTM D 3665.
 - a) If the thickness is determined to be deficient, additional test holes may be required to identify the limits of the deficient areas.
- B. Non-Conforming Work
 - 1. Correct deficiencies uncovered by the measurements or Samples.
 - a. Rework and retest areas represented by noncompliant tests.
 - b. Do not add thin layers of material to the top layer of base course to meet the specified grade.
 - 1) If the elevation of the top layer is 1/2 inch or more below grade, scarify the top layer of the base to a depth at least 3 inches, add new material, and blend and re-compact the material to bring it to grade.
 - c. If the finished surface is above the design grade, cut the material back to grade and re-roll the surface.
 - 2. If the base has been covered or it is otherwise impractical to correct the deficiency, take the corrective measures in Table 02721-2 at no increase in Contract Price.



Table 02721-2 Aggregate Base Course Thickness and Plasticity Deficiency		
Type	Deficiency	Corrective Measure
I	1/2 inch or more but less than 1 inch in thickness	Place asphalt chip seal using pre-coated chips in accordance with MAG Section 330 for the full roadway width over the area involved, but for not less than 660 feet or one City block in length.
II	1 inch or more in thickness	Place an additional asphalt concrete overlay, a 3/8-inch mix 1/2 the thickness of the deficiency for the full roadway width over the area involved, but for not less than 660 feet or one City block in length.
III	A plasticity index of 6 to 7 inclusive ⁽¹⁾	Place a 1/2 inch thick asphalt concrete overlay over the same total area as required for Types I and II.
IV	A plasticity index over 7 ⁽¹⁾	Remove deficient material from the affected area, and replace the removed material with material complying with the Specifications.
1. The plasticity index must be in accordance with AASHTO T 146 Method A (Wet Preparation), AASHTO T 89, and AASHTO T 90.		

3.06 CLEANING

- A. Remove tools, construction equipment and machinery, and surplus materials from the Site.
- B. Waste Management:
 - 1. Remove waste materials, rubbish, and debris from and about the premises.
 - 2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Limit traffic on compacted aggregate base course to final surfacing traffic and vehicles applying moisture control.
 - 1. Equipment used to construct adjoining sections may be routed over completed portions of the base course provided no damage results and the equipment is routed over the full width of the base course so rutting or uneven compaction is avoided.
- B. Maintain the base course in a condition complying with specified requirements until the Work is accepted.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 02741

BITUMINOUS CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for placing bituminous concrete as a surface course, base course, and/or curb upon a previously prepared base or subgrade as shown on the Contract Drawings or as ordered in writing by the Program/Project Manager.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 02786 - Tack Coat.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. COP: City of Phoenix.
 - 2. JMF: Job Mix Formula.
 - 3. MAG: Maricopa Association of Governments.
- B. Definitions:
 - 1. Screed: Any strike off device that operates by cutting, crowding, or other practical action which is effective on mixtures at workable temperatures without tearing, shoving, or gouging, and which will produce a finished surface of the smoothness and texture required.
 - 2. Leveling Course: A layer of material used to bring existing pavement to a uniform grade prior to placing an overlay or other course.
 - 3. Float Rock: Aggregate that has segregated to the surface of an asphalt concrete pavement course.
- C. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO T 168 – Standard Method of Test for Sampling Bituminous Paving Mixtures.
 - b. AASHTO T 245 – Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM D 29 – Standard Test Methods for Sampling and Testing Lac Resins [*withdrawn 2005 without replacement*].



- b. ASTM D 36 - Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
- c. ASTM D 464 - Standard Test Methods for Saponification Number of Naval Store Products Including Tall Oil and Other Related Products
- d. ASTM D 465 - Standard Test Methods for Acid Number of Naval Stores Products Including Tall Oil and Other Related Products
- e. ASTM D 2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
- 3. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction:
 - 1) Section 406 - Asphaltic Concrete.
 - 2) Section 407 - Asphaltic Concrete Friction Course.
 - 3) Section 408 - Recycled Asphaltic Concrete.
 - 4) Section 409 - Asphaltic Concrete (Miscellaneous Structural).
 - 5) Section 410 - Asphalt-Rubber Stress-Absorbing Membrane.
 - 6) Section 411 - Asphaltic Concrete Friction Course (Miscellaneous).
 - 7) Section 412 - Pavement Fabric Interlayer.
 - 8) Section 413 - Asphaltic Concrete (Asphalt-Rubber).
 - 9) Section 414 - Asphaltic Concrete Friction Course (Asphalt-Rubber).
 - 10) Section 416 - Asphaltic Concrete – End Product.
 - 11) Section 417 - Asphaltic Concrete (End Product) SHRP Volumetric Mix.
 - 12) Section 1005 - Bituminous Materials for Surfacing.
 - 13) Section 1009 - Asphalt-Rubber Material.
 - b. Arizona Stored Specifications:
 - 1) Section 406 - Asphaltic Concrete (406ASP, 03/17/08).
 - 2) Section 406 - Asphaltic Concrete (Miscellaneous Paving) (406ACMSP, 01/23/07).
 - 3) Section 406 - Bituminous Material for Pavement Replacement (406BIMX, 07/31/90).
 - 4) Section 407 - Asphaltic Concrete Friction Course with Mineral Admixture (406ADMIX, 03/17/08).
 - 5) Section 408 - Cold Recycling (Bituminous Surface) (408COREC, 05/18/06).
 - 6) Section 409 - Asphaltic Concrete (Miscellaneous Structural) – Mineral Aggregate (409AGGR, 02/20/08).
 - 7) Section 409 - Asphaltic Concrete (Miscellaneous Structural) (409ACMS, 02/20/08).
 - 8) Section 410 - Asphalt-Rubber Stress-Absorbing Membrane (410ARSAM, 02/20/08).
 - 9) Section 411 - Asphaltic Concrete Friction Course (Miscellaneous) (411ACFMS, 08/13/07).
 - 10) Section 413 - Asphaltic Concrete (Asphalt-Rubber) (413ACAR, 03/17/08).



- 11) Section 414 - Asphaltic Concrete Friction Course (Asphalt-Rubber) (414ACFAR, 03/17/08).
- 12) Section 415 - Asphaltic Concrete (Asphalt-Rubber) – End Product (415AREP, 03/17/08).
- 13) Section 416 - Asphaltic Concrete – End Product (416ACES, 03/17/08).
- 14) Section 416 - Asphaltic Concrete – End Product With Rolling Requirements (416ROLL, 03/17/08).
- 15) Section 417 - Asphaltic Concrete (End Product) SHRP Volumetric Mix (417SHRP, 03/17/08).
- c. ADOT Standard Drawings – Construction Standards.
4. Asphalt Institute (AI):
 - a. AI SP-2 – Superpave Mix Design
 - b. AI MS-2 – Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types
5. City of Phoenix (COP):
 - a. City of Phoenix Standard Details:
 - 1) Detail No. P1102 Depth of Base Course (Residential Street).
 - 2) Detail No. P1103 Depth of Base Course (Local Commercial & Light Industrial Streets).
 - 3) Detail No. P1104 Depth of Base Course (Major Streets & Heavy Industrial Streets).
 - b. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 1) Section 321 – Asphalt Concrete Pavement.
 - 2) Section 710 - Asphalt Concrete.
6. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications for Public Works Construction:
 - 1) Section 330 – Asphalt Chip Seal.
 - 2) Section 334 - Preservative Seal for Asphalt Concrete.
 - 3) Section 713 - Emulsified Asphalts.
 - b. Uniform Standard Details for Public Works Construction:
 - 1) Standard Detail No. 201 - Pavement Section at Termination.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Depending on where the paving operation is to occur and the owner of the right-of-way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport.
 2. Adhere to each owner's specifications and/or permits, and comply with additional requirements of the owners, regarding the Work of this Section.



3. If the owner of the right-of-way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of-way will be provided on the Contract Drawings.

B. Sequencing:

1. Include provisions for traffic control during concrete paving operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the pavement from traffic.

C. Scheduling:

1. Submit a detailed sequence and schedule of bituminous concrete placement operations including, but not limited to; plant location, width of the pavement to be placed, proposed equipment, production rates, working hours, bituminous concrete hauling and number of trucks available, placement methods, and cutting and sealing methods.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Samples:
 - 1) Mineral aggregate.
 - b. Delegated Design Submittals:
 - 1) Bituminous concrete mix designs.
 - 2) Bituminous concrete pavement Quality Control and Placement Plan.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Reports:
 - 1) Delivery tickets (Weigh Master's Certificates) for asphalt materials.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Special Warranty for bituminous concrete pavement.
 - b. Record Documentation:
 - 1) As-built information recording the actual depths and profiles of the bituminous concrete pavement.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Required approvals depend on who owns the right-of- way and where the bituminous concrete paving is to be constructed, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport Design and Construction Services.
 - 2. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver asphalt mixtures to the Site without segregation of the ingredients and within the temperature range specified in Section 321 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 2. At the time each asphalt mixture is delivered to the Site, submit a delivery ticket (Weigh Master's Certificate) to the Program/Project Manager containing the following information for information:
 - a. Date.
 - b. Supplier's name.
 - c. Plant location and/or plant number.
 - d. Ticket number.
 - e. Contractor's name.
 - f. Project name and/or location.
 - g. Product code/description with percent asphalt.
 - h. Mineral filler/additive and percent.
 - i. Temperature and batching.
 - j. Time of batching, arrival, and unloading.
 - k. Material weight or vehicle weight with and without material.
 - l. Weight of additive loads.
- B. Storage and Handling Requirements:
 - 1. Stockpile, store, and handle aggregate in accordance with the requirements specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.



1.07 SITE CONDITIONS

A. Ambient Conditions:

1. For base paving 2 inches thick or greater, verify that the atmospheric temperature is 40 degrees Fahrenheit and rising before proceeding.
2. For surface paving or pavement less than 2 inches thick, verify that the surface temperature is 50 degrees Fahrenheit or greater before proceeding.

1.08 WARRANTY

A. Special Warranty:

1. Remove bituminous concrete pavement mix whose stability is affected by excess asphalt cement content to such an extent that the pavement is displaced under normal traffic loads within a period of 1 year after acceptance, and replace it with new material at no increase in Contract Price.
2. Submit a written Special Warranty for bituminous concrete pavement to the Program/Project Manager warranting the bituminous concrete pavement against displacement under normal traffic loads within a period of 1 year.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA:

- A. If the paving is within Arizona Department of Transportation (ADOT) right-of-way, comply with the material and construction requirements of the applicable Sections in the ADOT Standard Specifications for Road and Bridge Construction, of the applicable Arizona Stored Specifications, and of the applicable ADOT Standard Drawings.
- B. Submit a Quality Control and Placement Plan detailing methods of controlling the quality of the bituminous mix during placement operations.

2.02 MATERIALS

A. Manufacturers:

1. Use material manufacturers providing the type of asphalt materials specified and which comply with the requirements for Suppliers as specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.

B. Asphalt Concrete Materials:

1. Provide asphalt concrete materials complying with the requirements specified in Section 710 of the City of Phoenix Supplement to Maricopa



Association of Governments Uniform Standard Specifications for the type of asphalt paving required.

C. Tack Coat:

1. Provide tack coat complying with the requirements specified in Section 02786, Tack Coat, using emulsified asphalt grade SS-1 as specified.

2.03 MIXES

A. The City of Phoenix Materials Lab will provide the Job Mix Formula (JMF) letter for the "Standard Mix" required for the asphalt pavement at the Site.

1. The required gradation of mineral aggregate is given in Table 710 in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
2. The Job-Mix Tolerances Percentage of Asphalt Range is given in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
3. The allowable temperature range for mixing and placing asphalt is given in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.

B. Submit the mix designs to the Program/Project Manager for approval.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Ensure the base on which the asphalt concrete is to be placed is smooth, firm, and true to grade and cross-section as shown on the Contract Drawings.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.

B. Surface Preparation:

1. Base
 - a. If necessary to meet the conditions specified in Paragraph 3.01.A and if ordered by the Program/Project Manager, spread aggregate base or a leveling course of asphalt concrete compacted in layers not exceeding 2-inches in thickness to level irregularities such as dips, depressions, and sags.
 - 1) Maintain the base throughout the period of placing asphalt concrete.



- 2) Remove all irregularities such as humps or high spots to provide a smooth uniform grade and cross-section, so that subsequent surfacing will be of uniform thickness.
 - b. Install pavement terminations per MAG Standard Detail 201, Type A or Type B, on the street edges where no other curb or retainment has been installed.
 - 1) This applies to, but is not limited to, the centerline of half streets, diagonal or perpendicular end terminations, street edges without curb and gutter or single curb.
 2. Tack Coat
 - a. Apply a tack coat to all existing and to each new course of bituminous surfaces prior to placing a succeeding layer of bituminous mixed Material.
 - 1) Apply the tack coat in accordance with Section 02786, Tack Coat.
 - 2) Surfaces to be covered may require repair or patching as directed by the Program/Project Manager.
 - 3) When approved by the Program/Project Manager, the tack coat may be deleted when a succeeding layer of asphalt concrete is being applied over a freshly laid course that has been subjected to very little traffic.
 - b. Apply a tack coat to the vertical surfaces of existing pavements, curbs, and gutters against which asphalt concrete is to be placed.
 3. Construction Joints:
 - a. Trimming Construction Joints:
 - 1) Before a base or surface course is placed adjacent to cold transverse construction joints, trim the joints to create a vertical face by saw cutting the joints to their full depth and removing cut off material to expose a fresh surface.
 - 2) Cut the joint on a 10 to 15 degree skew from a perpendicular to the centerline of the street or roadway.
 - b. Joint Bulkheads:
 - 1) For short overnight intermissions in paving, a full depth bulkhead (i.e., wooden member) can be placed near the end of the day's pavement placement.
 - 2) Remove the bulkheads and excess material just prior to the placement of the following day's pavement.
 - c. Joint Heaters:
 - 1) If conditions warrant and it is deemed necessary by the Program/Project Manager, use an approved joint heater on cold transverse or longitudinal joints.
 - 2) Ensure the joint heater is capable of heating the joint to a minimum temperature of 200 degrees Fahrenheit for a minimum depth of 1/4 inch at a speed commensurate with that of the laydown machine.

RFI Tack Coat

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This has been approved by the Program/Project Manager



3.03 INSTALLATION

A. Equipment:

1. Mixing Equipment:

- a. Furnish a twin-shaft pug mill equipped with paddles of sufficient size and number to deliver a thorough and uniform mixture.
 - 1) Insulate boxes, hoppers, buckets, and similar receptacles furnished for weighing mineral aggregate, filler material, and asphalt, and the scales used to batch materials, against the vibration and movement of the rest of the plant to keep errors in weighing below 2 percent for any setting and 1-1/2 percent for any batch.
 - 2) Mount dial heads or readout devices separate from the batch plant and tower supports to nullify most vibrations from the readout.
 - 3) Promptly remove worn parts that would adversely affect the quality of the mixing or allow leakage from the discharge gate.
 - 4) Make adjustments in the equipment to eliminate dead areas in which the material does not move or is not sufficiently agitated.

2. Spreading and Finishing Equipment:

- a. Self-propelled mechanical spreader(s) and finishing equipment:
 - 1) Furnish self-propelled mechanical spreader(s) and finishing equipment equipped with a vibrating screed or strike off assembly capable of distributing not less than the full width of a traffic lane.
 - a) Furnish a screed adjustable to the required template and elevation.
 - b) Furnish self-propelled mechanical spreading and finishing equipment capable of having the forward speed of operation regulated so that no irregularities result in the surface texture or smoothness of the mat due to excessive forward speed of the spreading machine.
 - 2) Screed Control System:
 - a) Equip self-propelled mechanical spreading and finishing equipment with a control system capable of automatically maintaining the specified screed elevation.
 - b) Furnish a control system that is actuated automatically from either a reference line or surface through a system of mechanical sensors or sensor directed mechanisms or devices that maintains the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.
 - (1) When approved or requested by the Program/Project Manager, make the transverse slope control system inoperative and provide screed control by sensor directed automatic mechanisms that independently



- control the elevation of each end of the screed from the reference lines or surfaces.
- (2) If the Program/Project Manager determines that the automatic screed control operation is not practical under a particular set of conditions, the use of manual control may be ordered in lieu thereof, but the machine must still be equipped with the automatic device.
 - c) Furnish controls capable of working in conjunction with any of the following attachments:
 - (1) Ski-type device not less than 30 feet in length.
 - (2) Taut string line or wire set to grade.
 - d) Use the ski-type device, string line, or wire set described in Subparagraph 3.03.A.2.a.2.c.1 or 3.03.A.2.a.2.c.2 as directed by the Program/Project Manager.
 - (1) In conditions where a curb and/or gutter is not even and true to grade, the Program/Project Manager may require the Contractor to use the ski-type device or stringline to establish the grade of the asphalt concrete surface adjacent to the curb or gutter.
 - b. Spreader boxes:
 - 1) Equip the spreader box with a readily adjustable strike off blade.
 - c. Tired blade grader
 - 1) The use of a self-propelled pneumatic tired blade grader must have the approval, in writing, of the Program/Project Manager.
 - 2) Equip the tired blade grader with an automatic leveling device capable of accurately maintaining transverse slope of the blade at a preset angle.
 - 3) Furnish a grader blade not less than 12 feet long.
 - 4) Ensure that the blade control in motor graders is free from appreciable lost motion.
 - 3. Compaction Equipment
 - a. Furnish self-propelled and reversible rollers for compacting asphalt concrete having a minimum weight of 8 tons.
 - 1) Maintain the rollers to ensure smooth steering and the ability to smoothly stop, start, and reverse.
 - 2) Equip the rollers with an automatic device or devices capable of properly dispensing an approved releasing agent on the wheels to prevent the wheels from picking up the asphalt concrete.
 - a) Do not use diesel fuel as a releasing agent.
 - 3) Equip the rollers with scrapers to keep the wheels clean from asphalt and other debris
 - b. Pneumatic-tired rollers
 - 1) Furnish 2-axle tandem type pneumatic rollers having a roller width of not less than 5 feet.



- a) Furnish rollers with tires not less than 20 inches in diameter, all of the same size, and with treads acceptable to the Program/Project Manager.
 - b) Furnish rollers having an operating weight not less than 2000 pounds per tire, and with the tires spaced so that the entire gap between adjacent tires will be covered by the tread of the following tire.
 - (1) Inflate each tire to 90 psi, except as otherwise specified.
 - (2) The maximum allowable variance between tire air pressure and specified air pressure is 5 psi.
 - c) Equip pneumatic tired rollers with skirt-type devices mounted around the tires to maintain the temperature of the tires during the rolling process.
 - c. Steel-wheeled tandem rollers and vibratory rollers:
 - 1) Furnish rollers having straight steel wheels free from grooves and/or pits.
 - 4. Curb forming equipment:
 - a. Furnish an extrusion type machine for curb forming.
- B. Handling Asphalt Concrete:
- 1. Make sure the asphalt concrete mix is at a temperature within the job mix formula limits specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - a. Take the asphalt concrete temperature at a point 6 inches below the exposed surface of the material, in the truck, on the job Site, and just prior to placement.
 - b. Furnish and use tarpaulins to cover the loads during transportation if the temperature of the mixture is below the job mix formula limits specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 2. When releasing agents are placed in the truck bed, ensure that no free fluid is present in the truck bodies at the time the asphalt concrete is loaded.
 - a. Do not use diesel fuel as a releasing agent.
 - 3. Ensure the handling of the completed mixture at all times prevents segregation.
 - a. Handle all material within the self-propelled mechanical spreading and finishing equipment in a manner that prevents segregation of the aggregate.
 - 1) Include material-handling devices such as augers, screws, or slat conveyors on the equipment to prevent segregation.
 - a) Extend these devices to the final or termination point where the material is being transported within the equipment.



- 2) In the case of the screed, install auger extensions and vibrators wherever the screed is extended more than 1 foot beyond the end of the base auger or auger extension.
 - a) The Program/Project Manager may waive the auger extensions and vibrators when material is placed against an extremely uneven curb or edge over a short distance.
- 3) If any of the devices fail to function, terminate the paving operation immediately until repairs are completed.
 - b. Insure that asphalt material spread is free from areas of excess coarse or fine material.
4. Back trucks carrying asphalt material into self-propelled mechanical spreading and finishing equipment in a manner that will not jar the equipment excessively or move it out of line.
 - a. Securely attach the truck to the equipment during spreading and finishing.

C. Placing Asphalt Concrete:

1. Begin placement of pavement at points farthest from the source of supply, and progress continuously toward the source of supply, unless otherwise ordered by the Program/Project Manager.
 - a. Do not place more than 1/2 day's delivery to the Site in any one lane in advance of the other lanes.
 - b. Stagger the end of each lane in relation to the adjacent lane.
2. Use self-propelled mechanical spreading and finishing equipment for placing asphalt concrete, but do not allow the forward speed of operation of the equipment to exceed 55 feet per minute unless it can be demonstrated to the satisfaction of the Program/Project Manager that higher speeds will not affect the smoothness of the mat.
 - a. For locations where the mixture is to be placed over areas inaccessible to the specified spreading or compacting equipment or over areas where the use of the specified spreading and compacting equipment would not be practicable, have spreading or compacting the asphalt mixture by other means approved by the Program/Project Manager.
 - b. Spreader boxes will be permitted for alleys and on narrow paving projects where it is not practical to use self-propelled equipment.
 - 1) The use of spreader boxes must have the approval, in writing, of the Program/Project Manager.
 - 2) Minimize manipulation of the spreader box in order to obtain a smooth surface.
 - 3) Back trucks into the spreader box in a manner which will not jar the equipment excessively or move it out of line.
 - a) Securely attach the trucks to the equipment during spreading and finishing.
3. Place float rock that developed during the raking process on an underlying course or otherwise dispose of it.



- a. Never scatter float rock over the final course surface.
- D. Compacting Asphalt Concrete:
- 1. Use steel-wheeled tandem rollers or vibratory rollers where applicable.
 - a. In all cases, operate the larger of the 2 roller wheels in the forward position.
 - b. Operate vibratory rollers in accordance with standard practices and manufacturer recommendations.
- E. Leveling Course:
- 1. Use a leveling course when specified or when directed in writing by the Program/Project Manager to bring existing pavement to a uniform grade prior to placing an overlay or other course.
 - 2. After the prime coat or tack coat has been applied, spread the leveling course mixture to the proper width and to such depth as will compact to the required thickness.
 - a. The Program/Project Manager will determine actual quantities of the mixture required.
 - 3. Spread a leveling course only to a distance in advance of the following course covering it as ordered by the Program/Project Manager.
 - a. Do not place the leveling course less than one lane in width, but place the longest practical length for any one lay, preferably not less than 1200 feet.
 - b. Have the Program/Project Manager approve the exact width and length.
 - 4. Prior to finishing the leveling course by means of self-propelled spreading equipment, a spreader box, or motor graders, place the material in layers of 2 inches maximum compacted thickness.
 - 5. The Program/Project Manager may approve other means for placing the leveling course provided that the method provides a finish surface that does not vary from the design surface by more than the amount specified herein.
 - a. Minimize manipulation of controls of the paver in order to obtain a smooth surface.
 - 1) Unless otherwise permitted by the Program/Project Manager, do not make adjustments on less than 50 foot intervals except where the machine is equipped with electronic grade controls, and any adjustments may not result in a change in pavement thickness in excess of 1/8 inch.
 - 6. Thoroughly compact the leveling course, smooth and true to grade and cross-section, and free from ruts, humps, depressions, and irregularities.
 - a. Use a pneumatic tire or steel wheeled roller for leveling course compaction.
 - b. Roll the leveling course concurrently with the laydown of the leveling course.



- c. During the rolling operation, do not allow the speed of the roller to exceed 3 miles per hour.
 - d. Additional rollers may be required depending on the placement rate of the asphalt concrete.
 - 1) If an ample number of rollers are not present, adjust the placement rate to accommodate the roller speed.
- F. Asphalt Base and Surface Courses:
 - 1. Spread and finish asphalt base and surface courses by means of self-propelled mechanical spreading and finishing equipment, except as otherwise noted.
 - 2. When more than one course is placed, stagger the longitudinal joints of each course not less than 6 inches with relation to the longitudinal joints of the underlying course.
 - 3. Perform break down and compaction rolling with either steel-wheel or pneumatic-tire.
 - a. The compacted thickness of layers placed may not exceed 150 percent of the design thickness specified in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications except as otherwise provided in the Contract Drawings and Specifications, or if approved in writing by the Program/Project Manager.
 - b. Operate all rollers continuously from breakdown through finish rolling.
 - 4. Furnish sufficient rolling equipment to satisfactorily compact and finish the amount of mixture being placed.
 - a. Prior to placing any asphalt material, verify that the required type and number of rollers are on the Site and in acceptable operating condition.
 - 1) Vibratory rollers may be used in lieu of the steel-wheeled rollers; however, when the thickness of the asphalt is 1 inch or less all rolling must be done in the static mode.
 - 2) Furnish a minimum of two rollers with 2 operators on the Site at all times.
 - 3) Upon approval of the Program/Project Manager, one of the rollers may be a pneumatic tire roller.
 - b. During the rolling operation, the speed of the roller may not exceed 3 miles per hour.
 - 1) If an ample number of rollers are not present, adjust the placement rate to accommodate the roller speed.
 - 5. Begin breakdown rolling as soon as the mixture will bear the roller without undue displacement.
 - a. Roll longitudinally along the pavement, overlapping on successive trips by at least 1/2 but not more than 3/4 the width of the rear wheels.
 - b. On alternate trips of the roller vary the lengths slightly.
 - c. Ensure that the motion of the roller at all time is slow enough to avoid displacement of the mixture.



- d. The Program/Project Manager may require a pneumatic roller for one of the rolling operations.
 6. When more than one width of asphalt concrete material will be placed, do not roll a 6-inch strip adjacent to the area on which future material is to be laid until such material has been placed.
 - a. Do not leave the 6-inch strip unrolled for more than 2 hours after it is placed unless it is first heated with a joint heater before being rolled.
 - b. After the first strip or width has been compacted; place, finish and compact the second width in a manner similar to the first width except that the 6-inch width not previously compacted must also be compacted.
 7. If the mix was designed with the Marshall method in accordance with the Asphalt Institute's MS-2, continue rolling until the specific gravity of the compacted mixture is not less than 95 percent of the specific gravity of specimens composed of the same materials in similar proportions or composed of the same mixture compacted in the laboratory by the 75-blow method of AASHTO T 245.
 8. If the mix was designed with the Asphalt Institute's Superpave gyratory method in accordance with Asphalt Institute's SP-2, continue rolling until the specific gravity of the compacted mixture is not less than 93 percent of the maximum theoretical specific gravity according to ASTM D 2041 of specimens composed of the same materials in similar proportions or composed of the same mixture compacted in the laboratory.
 9. At any place not accessible to roller compaction, thoroughly compact the mixture with tampers, and where necessary finish with a hot smoothing iron to provide a uniform and smooth layer over the entire area compacted in this manner.
 10. Perform finish rolling using steel-wheeled rollers or vibratory steel-wheeled rollers operated in the static mode.
 11. The completed surface must be thoroughly compacted, smooth, true to grade and cross-section, and free from ruts, humps, depressions, or irregularities.
- G. Construction Joints:
1. Use a light coat of asphalt emulsion applied to the exposed edge before the joint is made, if it deemed necessary by the Program/Project Manager.
 2. Verify that construction joints formed when the fresh mixture is placed are dense and well sealed.
 3. Test transverse construction joints with a 25 foot straightedge in accordance with Paragraph 3.03.I.
- H. Curbs:
1. Place curbs using an approved extrusion type machine.
 - a. Have curb extrusion templates varying from the cross-section shown on the Contract Drawings approved by the Program/Project Manager.



2. Use a 1/2-inch asphalt mix in accordance with Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - a. Ensure one percent by weight of the total mixture consists of a granulated synthetic resin stiffener, Lexite or equal, in accordance with the following:
 - 1) Softening Point (Ring & Ball): 210 degrees Fahrenheit, minimum, in accordance with ASTM D 36.
 - 2) Acid Number: Less than 1.00 in accordance with ASTM D 465.
 - 3) Saponifiable Matter: Less than 1 percent in accordance with ASTM D 464.
 - 4) Iodine Number: 175 - 185 in accordance with ASTM D 29.
- I. Tolerances:
 1. Tolerances of Leveling and Surface Courses:
 - a. An acceptable leveling course surface may not vary more than 1/2 inch from the lower edge of a 25-foot straightedge placed parallel to the centerline of the roadway.
 - b. An acceptable finish course surface may not vary more than 1/4 inch from the lower edge of a 25-foot straightedge placed parallel to the centerline of the roadway.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Site Tests:
 - a. The Testing and Inspection Agency and the City of Phoenix Testing Laboratory will test the asphalt pavement provided under this Section.
 - b. Pavement Drainage Test:
 - 1) Test Procedure:
 - a) Before final acceptance and in the presence of the Program/Project Manager, the Testing and Inspection Agency will test the drainage of the streets paved with asphalt under this Section by applying water to the surface.
 - b) Provide the water for this test at no increase in the Contract Price.
 - 2) Acceptance Criteria:
 - a) Demonstrate that the pavement allows for proper drainage.
 - c. Mineral Aggregate Gradation Test:
 - 1) Test Procedure:
 - a) At least 3 weeks prior to using mineral aggregates, submit a sample of the combined aggregates to the City of Phoenix Testing Laboratory for verification it's gradation is within the tolerances for The Standard Mix.
 - 2) Acceptance Criteria:
 - a) Aggregate within the specified tolerances will be acceptable.



d. Asphalt Pavement Thickness Test:

1) Test Procedure:

- a) If in the opinion of the Program/Project Manager there is reason to believe that the pavement thickness is deficient, the City of Phoenix Testing Laboratory will take cores to verify conditions at random locations as follows:
 - (1) 1 core will be taken for each 8 feet or portion thereof of width and for every 500 feet of lineal distance.
 - (2) 1 core will be taken for each 8 feet of width between intersecting streets or portion thereof.
 - (3) If a deficiency of more than 1/4 inch from the required thickness is found, 2 additional cores will be taken not closer than 100 feet apart or closer than 100 feet to the original deficient core.
 - (a) The average of these 3 cores will be used to determine the amount of any deficiency.
 - (4) Core thickness will be determined by average caliper measurement.
- b) Further cores may be taken by the Contractor, if he so chooses to determine the limits of the deficiency, if at no increase in the Contract Price.
 - (1) These cores will not be used to determine the average thickness of the pavement.
 - (2) Coring to establish if the pavement is deficient will be at no increase in the Contract Price.

2) Acceptance Criteria:

- a) Asphalt pavement of the specified thickness will be acceptable.

e. Asphalt Density Test:

1) Test Procedure:

- a) When in the opinion of the Program/Project Manager there is reason to believe that the compaction of the mixture is deficient, the City of Phoenix Testing Laboratory will take cores to verify conditions at random locations as follows.
 - (1) 1 core will be taken for each 8 feet or portion thereof of width and for every 500 feet of lineal distance.
 - (2) 1 core will be taken for each 8 feet of width between intersecting streets or portion thereof.
 - (3) If a deficiency of more than 1 percent from the required specific gravity defined in Subparagraph 3.03.F.7 or Subparagraph 3.03.F.8 is found, 2 additional cores will be taken not closer than 100 feet apart or closer than 100 feet to the original deficient core.
 - (a) The average of these 3 cores will be used to determine the amount of any deficiency.



- (4) Further cores may be taken by the Contractor, if he so chooses to determine the limits of the deficiency, if at no increase in the Contract Price.
 - (a) These cores will not be used to determine the average specific gravity of the pavement.
 - (b) Coring to establish if the pavement is deficient will be at no increase in the Contract Price.
 - 2) Acceptance Criteria:
 - a) Asphalt pavement having the required specific gravity defined in Subparagraph 3.03.F.7 or Subparagraph 3.03.F.8 will be acceptable.
 - f. Asphalt Cement Content Test:
 - 1) Test Procedure:
 - a) Samples will be secured from the roadway by City of Phoenix Testing Laboratory in accordance with the provisions of Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications and AASHTO T 168 for the purpose of determining asphalt cement content.
 - b) If the asphalt cement content determined by tests performed on the samples exceeds the limits established in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications, for each deficient test taken 2 additional cores not closer than 100 feet apart or closer than 100 feet to the original core will be taken, and the testing on these 2 additional cores will be repeated.
 - c) The average of all 3 tests made will be used to determine the asphalt cement content.
 - 2) Acceptance Criteria:
 - a) Asphalt pavement of having cement content within the limits established in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications will be acceptable.
 - 2. Inspections:
 - a. The Program Project Manager will measure the base, leveling, and surface courses to verify they are within the tolerances specified in Subparagraph 3.03.I.1.
 - b. Prepare and submit as-built information recording the actual depths and profiles of the pavement to the Program/Project Manager for information.
- B. Non-Conforming Work
- 1. Drainage Deficiencies:
 - a. Correct any areas not draining properly, as demonstrated by the Pavement Drainage Test described in Paragraph 3.04.A.1.b, to the Program/Project Manager's satisfaction.



- b. Correct drainage deficiencies at no increase in the Contract Price.
 2. Mineral Aggregate Gradation Deficiencies:
 - a. When the mineral aggregate gradation deviates from the specified requirements in an amount that, in the opinion of the Program/Project Manager, will affect the stability or durability of the mix, do either of the following:
 - 1) Remove and replace the asphalt concrete pavement with material that meets the requirements of this Section.
 - 2) Place an additional mat of such thickness and gradation as required by the Program/Project Manager which will, in the opinion of the Program/Project Manager, correct the deficiency.
 - b. Repair mineral aggregate gradation deficiencies at no increase in the Contract Price.
 3. Pavement Thickness Deficiencies:
 - a. When a deficiency of pavement thickness discovered by using methods described in Paragraph 3.04.A.1.d exceed 1/2 inch, overlay the pavement on the area affected as follows:
 - 1) Overlay not less than one city block or 660 feet, whichever is less in length, for the full width of the deficient area.
 - 2) Overlay the area specified in Paragraph 3.04.A.1.d with a new mat of material as specified by the Program/Project Manager and equal in thickness to the deficiency but not less than 1/2 inch in any instance.
 - b. Overlay deficiencies in thickness at no increase in the Contract Price.
 4. Pavement Compaction Deficiencies:
 - a. When a deficiency of the pavement density discovered by using methods described in Paragraph 3.04.A.1.e exceeds 5 percent, which is a greater deviation than the permitted deviation, overlay the pavement in the area affected with a standard pre-coated chip seal complying with the requirements of with MAG Section 330.
 - 1) Overlay not less than one city block or 660 feet, whichever is shorter, for the full width of the deficient area.
 - b. Overlay pavement compaction deficiencies at no increase in the Contract Price.
 5. Asphalt Cement Content Deficiencies:
 - a. When the asphalt cement content is in excess of the limits established in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications, remove any areas of bleeding as directed by the Program/Project Manager, but in no case less than the specified roller width.
 - 1) Replace the affected material with new material meeting the specification requirements for the mix type involved.
 - 2) At any time bleeding occurs within the period lasting from placement until 1 year after placement, remove and replace defective material until the bleeding has been corrected.



- b. When the deviation of the pavement asphalt cement content exceeds 0.2 percentage points by weight from limits established in Table 710-7 in Section 710 of the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications, which is a greater deviation than the permitted deviation, overlay the pavement on the area affected with a standard pre-coated chip seal in conformance with MAG Section 330.
 - 1) Overlay not less than one city block or 660 feet, whichever is shorter, for the full width of the deficient area.
 - c. Repair asphalt cement content deficiencies at no increase in the Contract Price.
- 6. Leveling Course Deficiencies:
 - a. Correct leveling course deviations that exceed the tolerances specified in Subparagraph 3.03.I.1, such as humps, or depressions, to meet the specified tolerance.
 - b. Adjustment in the cost for the material may be requested by either the Owner or the Contractor depending on the type of deviation.
 - c. Provide the labor and equipment necessary to correct such deviations at no increase in the Contract Price.
- 7. Asphalt Base and Surface Course Deficiencies:
 - a. If asphalt base and surface course deviations that exceed the tolerances specified in Subparagraph 3.03.I.2 such as humps and depressions are found, do either of the following:
 - 1) Correct asphalt base and surface course deviations.
 - 2) Cut out the deviating areas along neat straight lines and replace those areas with fresh hot mixture, and thoroughly compact them to conform and bond to the surrounding area.
 - b. Repair asphalt base and surface course deficiencies at no increase in the Contract Price.

3.05 CLEANING

- A. At the completion of the pavement construction, remove all forms, mixing and paving equipment, and traffic control devices furnished under this Section from the Site.

3.06 PROTECTION

- A. Apply an asphalt concrete preservative seal on all new asphalt concrete pavements in accordance with MAG Section 334, except as modified below.
 - 1. The Program/Project Manager will make a field determination whether the seal is required, and will then either provide the actual application rate or delete the requirement.
 - 2. This seal is not required for pavement matching and surface replacement over pipe trenches and other similar features unless specified on the Contract Drawings.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 02749

COLORED ASPHALT AND CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing a colored and coated asphalt and concrete surface here indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01555 - Traffic Control.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CIE: International Commission on Illumination.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. MAG: Maricopa Association of Governments.
 - 4. MEK: Methyl ethyl ketone, also known as butanone, is an organic compound with the formula $\text{CH}_3\text{C}(\text{O})\text{CH}_2\text{CH}_3$.
 - 5. QUV®: Q-Lab Corporation’s registered trademark for a series of accelerated weathering testers.
 - 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
 - 2. Decorative Colored Asphalt and Concrete: Asphalt and concrete pavement that has been subjected to coloring in a specific pattern.



Applying decorative coloring is a highly specialized process that requires the skill of a qualified applicator working with the proper equipment and applying highly specialized coating(s) designed specifically for application to asphalt and concrete pavement.

3. Non-textured Asphalt Pavement: Asphalt pavement that is unstamped and is sometimes referred to as “flatwork”.
4. Scuffing: Tearing of asphalt pavement caused by an external force, such as stationary vehicle tires turning on the pavement surface.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM D522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
 - b. ASTM D2486 - Standard Test Methods for Scrub Resistance of Wall Paints.
 - c. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
 - d. ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
 - e. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - f. ASTM E303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.
 - g. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non- Metallic Materials.
2. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - 1) Section 321 - Asphalt Concrete Pavement.
 - 2) Section 702 - Base Materials.
 - 3) Section 710 - Asphalt Concrete.
3. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications for Public Works Construction:
 - 1) Section 321 - Placement and Construction of Asphalt Concrete Pavement.
 - 2) Section 329 - Tack Coat.
 - 3) Section 702 - Base Materials.
 - 4) Section 710 - Asphalt Concrete.
4. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Include provisions for traffic control during operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the pavement from traffic.
- B. Sequencing:
 - 1. Insure the paving has been placed and is ready for application when scheduled.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Names of the pavement coating(s) and the coating supplier.
 - b. Shop Drawings:
 - 1) Proposed layout, patterns, colors, and extent of the colored paving.
 - c. Samples:
 - 1) Paving coating color and texture Samples.
 - d. Certificates:
 - 1) Pavement Coating Certificate of Analysis.
 - e. Special Procedure Submittals:
 - 1) List of the major colored paving application equipment.
 - f. Qualification Statements:
 - 1) Colored paving applicator's license.
 - 2) Applicator's certification of and references for each completed decorative paving project.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's storage instructions.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Colored Paving Coating Materials Warranty.
 - 2) Colored Paving Coatings Installation Warranty.



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Applicator's Qualifications:

- a. Employ a colored paving applicator licensed by a recognized authority in the execution of decorative paving work, and that has completed a minimum of 10 decorative paving projects, each project having at least 1000 square feet.
- b. Submit a copy of the colored paving applicator's current year license to the Program/Project Manager for confirmation and approval.
 - 1) Do not begin the colored paving Work until approval of the Applicator's qualifications is received.
- c. Submit a certification of and references for each completed decorative colored paving project to the Program/Project Manager for confirmation and approval.

2. Testing and Inspection Agency:

- a. Employ an independent certified materials testing laboratory approved by the Program/Project Manager and appropriate State and municipal departments that is experienced in performing the tests required by this Section to perform testing and certify the results.
- b. Submit the name and qualifications of the independent certified materials testing laboratory to the Program/Project Manager for approval.

B. Certifications:

1. Asphalt Pavement Coating Certificate of Analysis:

- a. Submit the Colored Pavement Coating Certificate of Analysis to the Program/Project Manager for approval.

C. Site Samples:

1. For each coating for colored paving, submit Samples representing the manufacturer's full range of available colors and textures to the Program/Project Manager for approval and color selection.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver material to the Site in original, sealed, undamaged, unopened containers clearly labeled by the manufacturer with the trade name, type, grade, shelf life, and other identifying data on an intact identification label.
2. Acceptance Documentation:
 - a. Record batch numbers, product identification, and quantities on appropriate Quality Control documents.
 - b. Attach a copy of the transport document and the Manufacturer's Certificate of Conformance to the material delivery Quality Control form.



- B. Storage and Handling Requirements:
 - 1. Store coating materials in air tight containers protected from the weather.
 - 2. Discard coating materials that have exceeded their shelf life without use.
 - 3. Store coating materials in strict accordance with manufacturers documented instructions.
 - a. Submit the coating materials manufacturer's documented storage instructions to the Program/Project Manager for information.
 - 4. Store hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of the local Authorities Having Jurisdiction.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Existing Conditions:
 - 1. The existing pavement was installed in accordance with the requirements for asphalt pavement specified in the Maricopa Association of Governments (MAG) Uniform Standard Specifications for Public Works Construction as modified by the City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - a. A durable and stable asphalt pavement mix design installed according to best practices over a properly prepared and stable substrate is a pre-requisite for long-lasting asphalt pavement surfaces.
 - b. Applicable sections of the standards are listed in Subparagraphs 1.02.C.2 and 1.02.C.3.

1.08 WARRANTY

- A. Manufacturer Warranty:
 - 1. Warrant the colored pavement coatings against defects in materials within the 1-year period after the Date of Substantial Completion:
 - a. The manufacturer's liability does not include variable factors out of the manufacturer's control, such as environmental conditions, application techniques, and surface conditions which are critical to the results obtained.
 - b. Submit a Colored Coating Materials Warranty on the colored pavement coating manufacturer's standard or customized form, without monetary limitation, in which the colored pavement coating manufacturer agrees to replace properly applied colored pavement coatings that fail in materials within the specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.



- B. Special Warranty:
1. Installer's Warranty:
 - a. Warrant the colored pavement coatings workmanship against failures within the 3-year period after the Date of Substantial Completion:
 - 1) Submit a Colored Pavement Coatings Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair colored pavement coatings that fail within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 COLORED PAVING

- A. Description:
1. Regulatory Requirements:
 - a. Comply with the Occupational Safety and Health Administration (OSHA) regulations stipulated in 29 CFR 1910 and 29 CFR 1926.
 2. Sustainability Characteristics:
 - a. Volatile Organic Compounds (VOC) Content of liquid-type auxiliary materials:
 - 1) Provide liquid-type auxiliary materials for the colored paving having volatile organic compound content less than 150 grams per liter when calculated according to Environmental Protection Agency (EPA) Reference Method 24 as described in 40 CFR 59, and that comply with the volatile organic compounds (VOC) limits of the Authorities Having Jurisdiction.
- B. Performance:
1. Provide colored pavement coating having at a minimum the performance properties specified in Table 02749-1.

Table 02749-1 Colored Pavement Coating Performance Properties		
Characteristic	Test Specification	Performance
Durability Taber Abrasion	ASTM D4060 Abrasion resistance of organic coatings (wet wear) 7 day cure, 24 hour soak; H-10 wheel	Wear Index (WI) < 5.0 (cycles to wear-through)
Color stability	ASTM G155 QUV® 2,000 hours (CIE units)	Brick color $\Delta E < 1.5$



Table 02749-1 Colored Pavement Coating Performance Properties		
Characteristic	Test Specification	Performance
Flexibility: Mandrel Bend	ASTM D522 Flexibility as measured by mandrel bend	0.5mm thick sample passes 10mm at 21°C 0.5mm thick sample passes 125mm at -18°C
Chemical resistance	ASTM D2486 Modified MEK scrubs 16 dry mils	> 5000 (number of scrubs until 50% substrate exposed)
Adhesion to Asphalt	ASTM D4541	Substrate failure
Friction Wet	ASTM E303 British Pendulum Tester	> 55
Environmental Sensitivity	EPA Reference Method 24 or ASTM D3960 Volatile Organic Compounds	VOC < 150

C. Design Criteria:

1. Prepare Shop Drawings showing the proposed layout, patterns, colors, and extent of the colored paving.
2. Submit the Shop Drawings of the colored paving to the Program/Project Manager for approval.

D. Materials:

1. Colored Pavement Coatings:
 - a. Furnish properly designed colored pavement coatings having the optimal balance of performance properties scientifically formulated to provide a durable, long lasting color and texture when applied to colored pavement surfaces.
 - 1) Key properties are specified in Table 02749-1, and include wet wear durability, crack resistance, and fade resistance, adhesion, and friction properties.
 - 2) The colored pavement coating must be environmentally safe and meet Environmental Protection Agency (EPA) requirements for Volatile Organic Compounds (VOC).
 - b. Submit the name of the colored pavement coating(s) and the coating supplier's name to the Program/Project Manager for approval.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:



1. Asphalt Pavement:
 - a. Verify that the asphalt pavement to receive the coating is highly stable and free of defects.
 2. Concrete Pavement:
 - a. Verify that the concrete pavement to receive the coating is highly stable and free of defects.
- B. Evaluation and Assessment:
1. Do not install the pavement texturing system over poor quality asphalt or concrete pavement.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
 2. Protect equipment and surfaces not scheduled to receive asphalt/concrete paving coatings from damage from overspray, fall-out, or dusting.
- B. Surface Preparation:
1. Ensure that the asphalt/concrete pavement surface is dry and free from foreign matter, including but not limited to dirt, dust, de-icing materials, and chemical residue.
 2. Depending upon the condition and age of the pre-existing pavement, primer may be required.
 - a. If required, apply a suitable primer approved by the asphalt/concrete coating manufacturer.

3.03 APPLICATION

- A. Application Equipment:
1. Furnish specialized equipment for executing of the Work:
 - a. Asphalt Pavement Re-Heating Equipment:
 - 1) Furnish asphalt pavement re-heating equipment specifically designed for decorative asphalt.
 - 2) Furnish primary asphalt pavement re-heat equipment capable of cycling the application of heat, and allowing the equipment operator to check the pavement surface temperature during the heating process.
 - a) Furnish controls that enable the operator to gradually elevate the pavement temperature and ensure the pavement is not overheated or adversely affected.
 - b) Do not furnish heaters without these controls as the primary re-heating equipment.
 - b. Portable Heating Devices:
 - 1) Furnish hand-held portable heating devices.
 - c. Finishing Tools:



- 1) Furnish finishing tools designed to enable applicators to complete imprinting of the asphalt pavement in areas inaccessible to the template, such as curbs and manhole covers.
 - d. Compactors:
 - 1) Furnish vibratory plate compactors for pressing the templates into the heated asphalt pavement to create the specified pattern.
 - e. Spray Equipment:
 - 1) Furnish spray equipment capable of applying the specialized asphalt/concrete pavement coating to the pavement surface in a thin, controlled film to optimize the drying and curing time of the coating.
 - a) Furnish a spray equipment pump capable of providing continuous recirculation of the coating that keeps the solids within the coating in suspension.
 2. Submit a list of the major colored paving application equipment proposed for executing the Work to the Program/Project Manager for approval.
 - a. Include the colored pavement reheat machinery, spray equipment, and compactor(s), in the list.
- B. Layout:
1. Layout of the pattern for coating of the surface of the asphalt/concrete pavement as indicated in the Contract Drawings.
- C. Heating the Asphalt Pavement:
1. Cycle the application of heat, and check the pavement surface temperature during the heating process.
 - a. Gradually elevate the pavement temperature, but do not overheat or adversely affect the pavement.
 - b. For areas where it is difficult to operate asphalt pavement re-heat machines, use hand-held portable heating devices.
 - 1) These may not be used as the primary pavement re-heating device.
 2. The optimal pavement temperature for imprinting the template is dependent upon mix design, modifiers used in the mix, the age of the pavement, and the weather.
 - a. Do not allow the surface temperature of the pavement to exceed 325 degrees Fahrenheit as determined by an infra-red thermometer reading taken after the heat is applied to the asphalt pavement.
 - b. In order to achieve the proper depth of imprint, elevate the asphalt pavement temperature to a minimum depth of 1/2 inch (12.5mm) without burning the pavement surface.
- D. Applying Asphalt/concrete Pavement Coatings:
1. Coat the pavement surface with a coating or system of coatings specifically formulated as a colorant for asphalt/concrete pavement as a colorant.



2. Verify that the pavement surface is completely dry and thoroughly cleaned prior to application of the asphalt/concrete pavement coating(s).
3. Coat the pavement surface in accordance with the asphalt/concrete pavement coating supplier's specifications and recommendations for application.
 - a. Apply the asphalt/concrete pavement coatings in environmental conditions that permit proper cure.
 - b. Apply the coating in accordance with the asphalt/concrete pavement coating supplier's recommendations for coating coverage rate, number of recommended passes, and recommended film thickness.
 - c. Submit the asphalt/concrete pavement coating supplier's specifications and recommendations for application to the Program/Project Manager for information.

3.04 SITE QUALITY CONTROL

- A. Site Inspections:
 1. The Program Project Manager will inspect the asphalt/concrete paving coating to verify it complies with the specified requirements.
- B. Non-Conforming Work
 1. Remove defective work, and replace it with acceptable asphalt/concrete paving coatings.

3.05 CLEANING

- A. At the completion of the asphalt/concrete paving coating application, remove all equipment, and traffic control devices, required to facilitate the Work of this Section from the Site.
- B. Waste Management:
 1. Remove waste materials in accordance with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 2. Dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of the local Authorities Having Jurisdiction.

3.06 PROTECTION

- A. Do not permit traffic on the coated asphalt/concrete pavement surface before the surface coating is 100 percent dry.
 1. Provide the necessary personnel and equipment to divert traffic from the installation area where Work is in progress and during drying time when, in the opinion of the Program/Project Manager, diversion of traffic is necessary.



2. Refer to the asphalt/concrete pavement coating supplier's guide for other required protective measures.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/20017	N/A	All	First edition.





SECTION 02751

PLAIN CEMENT CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for construction of plain jointed Portland cement concrete pavement on a prepared subgrade.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 02339 - Subgrade Preparation.
 - 5. Section 02702 - Concrete Curb, Gutter, Driveway, Sidewalk, and Alley Entrance.

1.02 REFERENCES

- A. Definitions:
 - 1. Internal Joint Surface: The full depth surface of the crack created as the result of saw cutting a joint in the concrete pavement.
 - 2. Primary Unit of Pavement: The area of pavement placed in each day's paving operation, in an intersection, or in a special section.
 - 3. Secondary Unit of Pavement: 1,000 linear feet, or excess fraction thereof, of each traffic lane; or each 1,300 square yards of pavement in intersections and similar areas, regardless of when the concrete was placed.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO T 148 - Measuring Length of Drilled Concrete Cores.
 - b. AASHTO T 176 - Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 - 2. American Concrete Institute (ACI):
 - a. ACI Manual of Concrete Practice.
 - b. ACI 305R - Hot Weather Concreting.
 - c. ACI 306R - Cold Weather Concreting.
 - d. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary (Includes International Conference of Building Officials Evaluation Report).
 - 3. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction.



- 1) Section 401 – Portland Cement Concrete Pavement.
- 2) Section 402 – Portland Cement Concrete Pavement Repairs.
- 3) Section 1003 – Reinforcing Steel.
- 4) Section 1006 – Portland Cement Concrete.
- 5) Section 1011 – Joint Materials.
- b. Arizona Stored Specifications:
 - 1) Section 401– Portland Cement Concrete (C-22.10 Utility Line Slab) - (401PCCUC, 04/15/91)
 - 2) Section 401– Portland Cement Concrete (Latex Modified Overlay) – (401LMCO, 05/15/92)
 - 3) Section 401– Load Transfer Dowel Assembly – (401LTDA, 11/01/93)
 - 4) Section 1006 – Portland Cement Concrete – (1006QCPC, 07/12/05)
- c. ADOT Standard Drawings – Construction Standards.
- d. ADOT Materials Testing Manual:
 - 1) Arizona Test Method 801a – Evaluation of Profiles.
4. ASTM International (ASTM):
 - a. ASTM A 615/A 615M - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - b. ASTM C 31/C 31M - Practice for Making and Curing Concrete Test Specimens in the Field
 - c. ASTM C 33 - Specification for Concrete Aggregates
 - d. ASTM C 39/C 39M - Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - e. ASTM C 78 - Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
 - f. ASTM C 150 - Specification for Portland Cement
 - g. ASTM D 1751 - Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 - h. ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate
 - i. ASTM D 3406 - Specification for Joint Sealant, Hot-Applied, Elastomeric Type, for Portland Cement Concrete Pavements
5. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Specifications for Public Works Construction:
 - 1) Section 725 – Portland Cement Concrete
 - 2) Section 726 – Concrete Curing Materials
 - 3) Section 729 - Expansion Joint Filler
 - b. MAG Uniform Standard Details for Public Works Construction:
 - 1) Standard Detail 224 - Joint for Drainage Inlets and Manhole Covers.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Depending on where the paving removal operation is to occur and the owner of the right-of- way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Streets Department.
 - c. Phoenix Sky Harbor International Airport.
2. Adhere to each owner's specifications and/or permits, and comply with additional requirements of the owners, regarding the Work of this Section.
3. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.

B. Sequencing:

1. Include provisions for traffic control during concrete paving operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of 7 Days after concrete placement.

C. Scheduling:

1. Submit a detailed sequence and schedule of concrete placement operations including, but not limited to; plant location, width of the pavement to be placed, proposed equipment, production rates, working hours, concrete hauling and number of trucks available, placement methods, and curing, sawing and sealing methods.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Portland cement.
 - 2) Aggregates.
 - 3) Concrete reinforcement.
 - 4) Metal sleeve design for use with dowel bars.
 - 5) Basket support for holding reinforcing steel bars parallel to pavement surface.
 - 6) Concrete Curing Materials.
 - 7) Joint Materials.
 - b. Shop Drawings:



- 1) Working Drawings of the plain cement concrete pavement.
 - c. Certificates:
 - 1) Certificates of Analysis for hydraulic cement.
 - 2) Certificates of Compliance for joint sealant.
 - 3) Certificates of Compliance for expansion joint filler.
 - d. Delegated Design Submittals:
 - 1) Mix designs for plain cement concrete pavement.
 - 2) Sequence and schedule of plain cement concrete pavement placement operations.
 - e. Qualification Statements:
 - 1) Qualifications of the certified materials testing laboratory.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Data from modulus of rupture tests demonstrating that concrete will conform to the modulus of rupture requirements of the Specifications.
 - 2) Data results of compressive strength tests conducted at the same age as modulus of rupture tests to establish the correlation.
 - 3) Optional compressive strength test of specimens fabricated in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M.
 - 4) Test records and all other required testing documentation.
 - b. Manufacturer's Instructions:
 - 1) Data for fog spraying equipment used for applying water to the pavement surface during screeding and finishing operations.
 - 2) Design, capacity, and mechanical condition of equipment and tools.
 - c. Manufacturer's Reports:
 - 1) Shipping documents for reinforcing steel.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built information recording the actual depths and profiles of the plain cement concrete pavement.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Right-of Way Owner Approvals:



- a. Required approvals depend on who owns the right-of-way and where the plain concrete pavement is to be constructed, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - 1) Arizona Department of Transportation (ADOT).
 - 2) City of Phoenix Streets Department.
 - 3) Phoenix Sky Harbor International Airport Design and Construction Services.
 - b. If the owner of the Right-of-Way is other than the Phoenix Sky Harbor International Airport, the owner of the Right-of-Way will be provided on the Contract Drawings.
- B. Certifications:
 - 1. Submit Certificates of Analysis for hydraulic cement that include the following information:
 - a. Description of material supplied.
 - b. Quantity represented by the Certificate.
 - c. A means of identifying the material, such as a label, lot number, or marking.
 - d. A statement certifying the material complies with the requirements of specifications cited.
 - e. The name, title and signature of a person having the authority to bind the manufacturer or Supplier of the material.
 - f. The results of the tests required by the Specifications.
 - 2. Submit Certificates of Compliance for both joint sealant and expansion joint filler that include the following information:
 - a. Description of material supplied.
 - b. Quantity represented by the Certificate.
 - c. A means of identifying the material, such as a label, lot number, or marking.
 - d. A statement certifying the material complies with the requirements of specifications cited.
 - e. The name, title and signature of a person having the authority to bind the manufacturer or Supplier of the material.
- C. Preconstruction Testing:
 - 1. Employ an independent certified materials testing laboratory approved by the Program/Project Manager and appropriate State and municipal departments that is experienced in performing all of the tests required by this Section to perform or witness testing and certify the results.
 - 2. At least 30 days in advance of the start of concrete paving operations, submit data acceptable to the Program/Project Manager which demonstrates that concrete, produced with materials and proportions as proposed for use in the construction, will conform to the modulus of rupture requirements of this Section.



- a. Fabricate modulus of rupture test specimens in accordance with ASTM C 31/C 31M and test specimens in accordance with ASTM C 78 at 14 Days and at 28 Days.
- b. Include results of compressive strength tests conducted at the same age as modulus of rupture tests to establish the correlation which can be expected between the flexural and compressive strength properties of the concrete.
- c. The Program/Project Manager may, at his option, have the Testing and Inspection Agency use a compressive strength test of specimens fabricated in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M to verify conformance to the modulus of rupture requirements of this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Submit 3 copies of the shipping documents for reinforcing steel to the Program/Project Manager for information that show the delivered sizes, lengths, and weights separately for each structure.
- B. Storage and Handling Requirements:
 1. Do not intermingle different types or brands of hydraulic cement, or use different types or brands in the same batch.
 2. Store and protect hydraulic cement from damage from moisture.
 - a. Do not use cement which has become partially set or which contains caked lumps.
 3. Store and handle concrete aggregate to minimize segregation and intermixing and contamination by foreign materials.
 - a. Separate different sizes of aggregates in separate stockpiles sufficiently removed from one another to prevent the material from becoming intermixed.
 - b. If aggregates are stored on the ground, level and clear the site of all vegetation.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Hot Weather Concreting:
 - a. If daytime ambient temperatures are expected to exceed 100 degrees Fahrenheit, place concrete only between the hours of 8:00 p.m. and 8:00 a.m.
 2. Take adequate steps to protect concrete placed during rain and hot or cold weather as defined in ACI Standards:
 - a. ACI 305R - Hot Weather Concreting.
 - b. ACI 306R - Cold Weather Concreting.



PART 2 PRODUCTS

2.01 DESIGN CRITERIA:

A. Concrete Paving Methods:

1. Slip-Form Paving Machine Supported on Subgrade Method:
 - a. Spread, consolidate, screed, and float-finish slip-form concrete in one complete pass of the slip-form paving machine.
 - b. Operate the slip-form paving machine as nearly as possible in the forward direction only, and coordinate all paving operations to provide uniform progress with minimal stopping and starting of the paving machine.
 - c. Rigidly hold the sliding side forms together to prevent their spreading.
 - d. While concrete is being spread, compacted, and shaped; operate vibrating units within the fresh concrete so that the longitudinal axis, at the center of each vibrating unit, is not more than 6 inches above the top of the subgrade.
 - e. Use a vibration amplitude that is sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating units and for a distance of at least one foot from the vibrating units.
2. Mechanical Equipment Supported on Fixed Form Method:
 - a. Strike off and consolidate concrete so that the surface conforms to the finished grade and cross-section shown on the Contract Drawings and has sufficient material on the surface for floating operations.
 - b. After concrete has been struck off and consolidated, float the concrete with a longitudinal float of a type approved by the Program/Project Manager.
 - c. A slip-form paving machine or a single machine which will effectively spread, consolidate, screed, and float in one operation may be used in lieu of separate finishing and floating equipment.
3. Manual Methods with Fixed Forms:
 - a. Deposit, spread, and strike off concrete to an elevation such that the surface will conform to the required lines and grades when properly consolidated.
 - 1) Keep a slight excess of concrete in front of the screed at all times during the strike-off operation.
 - b. Consolidate concrete by internal vibration as it is struck off with the screed.
 - c. After consolidation and screeding, tamp the concrete to the proper surface elevation and cross-section using either a heavy plank with a length in excess of the width of payment being placed by one foot or more, or with a mechanical vibrating unit spanning the full width between forms.
 - 1) If a tamping plank is used, stiffen it as necessary to prevent sag, and cover the lower tamping edge with a metal guard.



- 2) If a tamping plank is used, move the tamping plank forward with a combined vertical and longitudinal screeding motion so that the concrete will be thoroughly consolidated and the surface screeded to the required elevation.
 - 3) Keep a small surplus of concrete in front of the tamper or vibrating unit.
 - 4) Continue tamping or vibrating until the specified cross-section is obtained and the mortar is flushed slightly to the surface.
 - 5) In lieu of using a tamping plank for screeding, other methods may be utilized if they are approved by the Program/Project Manager.
 - d. On grades in excess of 5 percent a second strike board shall follow from 25 to 50 feet behind the tamper or vibratory unit, and used in the same manner to remove waves caused by the flow of concrete behind the first strike board.
 - e. Finish pavement smooth and true to grade with suitable manually operated floats or powered finishing equipment.
- B. If the paving is within Arizona Department of Transportation (ADOT) right-of-way, comply with the material and construction requirements of the applicable Sections in the ADOT Standard Specifications for Road and Bridge Construction and Arizona Standard Specifications, and with the applicable ADOT Standard Drawings.

2.02 MATERIALS

- A. Concrete Materials:
1. Portland cement:
 - a. Provide Portland cement conforming to the requirements of MAG Section 725.
 - b. As an option, Portland cement conforming to the requirements of ASTM C 150 for Type III, low alkali, may be used.
 2. Aggregates: Provide crushed rock or gravel conforming to the requirements of ASTM C 33.
 - a. Provide coarse aggregate gradation conforming to the requirements for Size No. 57.
 - b. Provide fine aggregate with an average sand equivalent of not less than 75 when tested in accordance with the requirements of AASHTO T 176 or ASTM D 2419.
- B. Concrete Reinforcement
1. Tie bars:
 - a. Provide deformed billet steel reinforcing bars conforming to the requirements of ASTM A 615/A 615M, Grade 40.
 2. Dowel bars:
 - a. Provide plain round bars conforming to the requirements of ASTM A 615/A 615M, Grade 40.



- 1) Paint one-half the length of each dowel bar with one coat of tar paint.
- 2) Provide metal sleeves of an approved design for use with dowel bars.
 - a) Design the sleeves to prevent collapse during construction.
 - b) Provide sleeves that cover 2 inches plus or minus 1/4 inch of the dowel.
 - c) Provide sleeves having a closed end with a suitable stop to hold the closed end at least 1 inch from the end of the bar.
- 3) Use an approved basket support to hold the bars parallel to pavement surface.

C. Concrete Curing Materials:

1. Provide concrete curing materials conforming to the requirements of MAG Section 726.

D. Joint Materials:

1. Joint Sealant:
 - a. Provide one component, hot poured type joint sealant, conforming to the requirements of ASTM D 3406.
 - b. If approved by the Program/Project Manager, other pour type joint sealants conforming to the requirements of MAG Section 729.2 may be used in lieu of that specified in Subparagraph 2.02.D.1.a.
2. Backer Rod or Tape and Bond Breakers:
 - a. Provide type that controls the depth of sealant, achieves the desired shape factor, supports the sealant against indentation and sag, and prevents the sealant from bonding to the bottom concrete surface.
 - b. Provide type that is compatible with the joint sealant Material.
3. Expansion Joint Filler:
 - a. Provide preformed expansion joint filler conforming to the requirements of ASTM D 1751.

2.03 MIXES:

A. Portland Cement Concrete:

1. Provide Portland cement concrete conforming to the applicable requirements of MAG Section 725 and the additional requirements of this Section.
2. Modulus of Rupture:
 - a. Not less than 520 psi within 14 Days after placement.
 - b. Not less than 650 psi at 28 Days.
3. Slump (Maximum):
 - a. Provide Portland cement concrete having a slump as determined by the approved mix design.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Ensure that the subgrade conforms to the compaction and elevation tolerances for the material involved.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Subgrade Preparation:
 - a. Prepare the subgrade in accordance with Section 02339, Subgrade Preparation.
 - b. Keep subgrade smooth, compacted, and free of all loose and extraneous material when concrete is placed.
 - 1) Check and correct the grade immediately ahead of concrete placement and properly re-compact all disturbed subgrade.
 - c. Keep the surface of the subgrade uniformly moist when concrete is placed.
 - 1) Moisten the surface of the subgrade immediately prior to placement of concrete if necessary to produce a uniformly moist condition.
 - 2) Remove excess water standing in pools or flowing on the surface prior to placing concrete.
 - d. Compact and cut to grade the subgrade under forms so that when the form is set it will be uniformly supported for its entire length at the specified elevation.

3.03 CONSTRUCTION

- A. Furnish all labor, materials, and equipment necessary for the construction of the pavement in accordance with the Specifications, and in reasonably close conformity to the lines, grades, thickness, and details indicated on the Contract Drawings or as established by the Program/Project Manager.
- B. Equipment:
 - 1. Equipment Approval:
 - a. Submit the design, capacity, and mechanical condition of equipment and tools necessary for handling materials and performing all parts of the Work to the Program/Project Manager for approval.
 - b. Transport equipment to the Site sufficiently ahead of the start of concrete paving operations to permit thorough examination and approval by the Program/Project Manager prior to the start of concrete paving.
 - 2. Equipment Capability:



- a. Furnish one or more machines for placing concrete that are capable of uniformly distributing and consolidating the concrete as it is placed without segregation, and that are capable of producing concrete pavement that will conform to the required cross-section with a minimum of handwork.
 - 1) Furnish an adequate number of machines with the capacity to perform the Work at a rate equal to the concrete delivery rate.
 - 2) If equipment will be used to place concrete adjacent to existing pavement or curb and gutter, equip that part of the equipment supported on the existing pavement or curb and gutter with protective pads on crawler tracks or with rubber-tired wheels with bearing surfaces offset a sufficient distance from the edge of the pavement or curb and gutter to avoid edge damage.
 - a) Alternatively, protect the surface of the existing pavement or curb and gutter against edge damage in a manner approved by the Program/Project Manager.
- 3. Slip-Form Paving Equipment:
 - a. If slip-form paving equipment is to be used, furnish equipment capable of being wholly or partially supported on the subgrade; and that has traveling side forms of sufficient dimensions, shape, and strength to support the concrete at free edges laterally for a sufficient length of time during placement to produce pavement of the required cross-section.
 - b. Furnish slip-form paving equipment that has automatic sensing and control devices to automatically sense deviations from the established guideline and cause the necessary corrective maneuvers required to overcome variations from correct grade and alignment to be performed.
- 4. Vibrators:
 - a. Rate of Vibration:
 - 1) Not less than 3500 cycles per minute for surface vibrators and not less than 8000 cycles per minute for internal vibrators.
 - 2) Furnish a tachometer or other suitable device for measuring and indicating the frequency of vibration.
 - b. For vibrators mounted on mechanical equipment, furnish power connections to the vibrators that cause vibration to cease when forward or backward motion of the equipment is stopped.
 - c. If slip-form paving equipment is to be used; furnish equipment with high frequency internal vibrators mounted with axes either parallel or normal to the pavement alignment for the full paving width.
 - 1) Space vibrators mounted with axes parallel with pavement alignment at intervals not exceeding 24 inches measured center to center.



- 2) Space vibrators mounted with axes normal to pavement alignment so that lateral clearance between individual vibrating units does not exceed 6 inches.
 5. Stationary Concrete Side Forms:
 - a. Furnish side forms having the cross-section and strength to resist the pressure of the concrete being placed when the forms are properly secured and supported on the subgrade.
 - b. Furnish concrete side forms with a base width of at least 4 inches and a minimum depth equal to the thickness of the pavement.
 - c. For straight sections, furnish metal concrete side forms that are straight and free from warps, bends, indentations, and other defects.
 - 1) Furnish sections that do not exhibit any variation from a true plane greater than 1/8 inch in 10 feet on the top of the form, or more than 1/4 inch in 10 feet on the inside face.
 - 2) If approved by the Program/Project Manager, suitable materials other than metal may be used to form end closures or at other locations where use of metal forms is not practical.
 - d. For curves of 100 feet radius or less, furnish flexible or curved forms of proper radius.
- C. Concrete Paving Methods:
1. Use one of the concrete paving methods described in Paragraph 2.01.A to construct the concrete pavement.
 2. Use either mechanical equipment in combination with stationary concrete side forms or slip-form paving equipment without stationary side forms, except as noted in Subparagraphs 3.03.C.2.a and 3.03.C.2.b.
 - a. For areas inaccessible to mechanical equipment, manual methods of placing and finishing concrete using stationary side forms may be permitted with the approval of the Program/Project Manager.
 - b. If approved by the Program/Project Manager, pavement lanes of irregular width or of widths less than 10 feet and those sections of intersections or other locations with complex variable surface configurations may be constructed using manual methods of placing, spreading, and compacting.
 3. If job conditions permit paving equipment to operate from outside the paving lane, do not operate the construction equipment on the subgrade in the paving lane.
 - a. If job conditions make it necessary to operate equipment on the subgrade in the paving lane, provide suitable runways or take other precautions to prevent rutting or displacement of subgrade material.
 - b. If concrete pavement will be placed using slip-form paving equipment which will be supported and operated on the subgrade, bring the subgrade and slip-form paving equipment track to the proper grade and cross-section by means of a properly designed and operated machine.



D. Concrete Side Forms:

1. Thoroughly clean and oil concrete forms each time they are used.
2. Set the forms to the required lines and grades well in advance of the time the concrete will be placed and at a distance sufficiently ahead of the pours to avoid delaying concrete placement, and have the forms in place approved by the Program/Project Manager prior to placing concrete.
 - a. If any form is disturbed or any grade becomes unstable, reset the form and recheck it.
3. Properly secure and support the forms on the subgrade so that they are capable of resisting the impact and vibration of any equipment they are to support without springing or settlement.
 - a. Support and secure the forms during the entire operation of placing and finishing so that the forms do not deviate vertically at any point more than 1/8 inch from the proper elevation.
4. Use a method of connecting the concrete form sections which insures that the joints do not move in any direction.
5. Maintain side forms in place until the edge of the pavement no longer requires the protection of the forms, and at a minimum until the day after concrete is placed.
 - a. When the time to remove the side forms comes, carefully remove the forms in a manner that prevents damaging the pavement.
 - b. Do not use pry bars between the pavement and the forms.

E. Placing and Spreading Concrete:

1. Have the materials and equipment needed for adequate curing at hand and ready to install before concrete placement begins.
2. Construct concrete pavement of the thicknesses indicated on the Contract Drawings and in the Specifications.
 - a. Do not use the tolerances given for base and subgrade construction or other provisions of this Section which may affect thickness, to modify the thickness requirements of the Contract Drawings and Specifications.
3. Except when otherwise approved by the Program/Project Manager, deposit concrete on the subgrade and spread it the full width between the forms using mechanical methods that result in a minimum of handling and segregation.
 - a. If it is necessary to hand spread the concrete, use shovels not rakes.
4. Continuously place the concrete between transverse joints without using intermediate bulkheads.
5. Make adequate advance arrangements to prevent delaying delivery and placing of the concrete.
 - a. An interval of more than 15 minutes between placing of any 2 consecutive batches is sufficient cause to stop operations, and requires installation of a construction joint in the concrete already placed at a location and of a type as directed by the Program/Project Manager.



6. Deposit concrete as near to expansion and construction joints as possible without disturbing them, do not dump concrete onto a joint assembly.

F. Compacting Concrete:

1. Thoroughly consolidate concrete against and along the faces of all forms, adjacent pavement and curb and gutter, and on both sides of all joint assemblies.
2. Use vibrators to consolidate concrete.
 - a. Do not permit vibrators to come in contact with joint assemblies, the grade, or side forms.
 - b. Do not operate vibrators longer than 15 seconds in any one location.
3. If concrete is spread without the use of internal vibration by the mechanical equipment supported on fixed forms method, equip the finishing machine with vibrating equipment that will internally vibrate the concrete for the full paving width and with not less than two oscillating or reciprocating screeds.
4. Do not allow workmen to walk in freshly placed concrete with boots or shoes coated in soil or other foreign materials.

G. Shaping and Initial Finishing:

1. Strike off, consolidate, and float finish concrete with slip-form paving equipment, a mechanical finishing machine, a vibrating screed, or by hand finishing methods if approved by the Program/Project Manager so that the complete pavement conforms to the thickness and cross-section requirements of the Contract Drawings and Specifications.
2. When the pavement being constructed is contiguous to existing parallel concrete pavement or curb and gutter, set the elevation of the new pavement as close as possible to the elevation of the existing pavement or gutter surface and in a manner which will prevent ponding.
3. Do not apply water to the pavement surface during screeding and finishing operations in excess of the amount lost by evaporation.
 - a. Adding water to the surface of the concrete to assist in finishing operations is not permitted.
 - b. When applications of water to the surface are required to prevent rapid evaporation of water from the surface during finishing operations, apply it as a fog spray with approved spray equipment.

H. Final Finishing:

1. After the pavement has been initially finished with a float, scrape the concrete with a 10-foot long straightedge equipped with a handle to permit operations from the edge of the pavement.
 - a. Remove excess water and laitance from the surface.
 - b. Operate the straightedge parallel to the centerline of the pavement, and move it forward one-half the length of the straightedge after each pass.
 - c. Correct irregularities by adding or removing concrete.



- 1) Scrape disturbed places with the straight edge again.
 2. Use long handled wood floats only in areas not accessible to finishing equipment and in emergencies.
 - a. Keep the use of long handled wood floats to a minimum.
 3. Do not add water to the surface of the concrete to assist in finishing operations unless doing so is approved by the Program/Project Manager.
 - a. If the adding water to the surface is permitted to prevent rapid evaporation of water from the surface during finish, apply the water as a fog spray with approved spray equipment.
 4. Construct edge joints and pavement edges in accordance with details shown on the Contract Drawings or as directed by the Program/Project Manager.
 5. Texture the pavement surface prior to curing operations.
 - a. The Program/Project Manager will finish the surface of a portion of the initial construction to demonstrate the final surface texturing that will be expected and approved by him.
 - 1) Do not change the approved surface finish as provided on the initial construction without approval by the Program/Project Manager.
 - b. Perform texturing by using an artificial turf drag with a board added to provide the weight needed to obtain an approved surface.
 - c. Provide artificial turf having a molded composite structure with a polyethylene face, nylon and polyester backing, a pile height of 0.85 inches, and a total weight of 75 ounces per square yard.
 - d. Each time the construction is stopped or the texturing is caused to stop, shake the artificial turf clean before continuing.
- I. Curing Concrete:
1. After finishing operations have been completed, cure the newly placed concrete by moist curing methods, by the application of a white liquid membrane compound, or a combination of these methods.
 - a. Begin curing immediately following surface texturing and edging.
 2. Keep all surfaces that are not covered by reasonably waterproof forms damp.
 - a. Apply water from a nozzle that atomizes the flow of water to form a fog mist, but not a spray, until one of the following occurs:
 - 1) The surface is covered with liquid membrane compound, or
 - 2) The surface has hardened sufficiently to permit sprinkling of the surface, or
 - 3) Moist curing by covering with wet burlap or other approved Materials is initiated.
 - b. Do not apply moisture from the nozzle, under pressure, directly upon the concrete.
 - c. Do not allow moisture to accumulate on the concrete in a quantity sufficient to cause a flow and erode the surface.



- d. Continue moist curing until a liquid membrane curing compound or other type of curing membrane is applied.
 3. The membrane method of curing may be applied behind the final finishing operation after all free water has disappeared from the surface.
 - a. Apply membrane curing compound to pavement using an automatic mechanical method from a construction bridge.
 - b. Provide complete and uniform coverage at a rate of one gallon per 100 square feet, or as otherwise recommended by the manufacturer.
 - c. Keep membrane curing compound agitated to prevent pigment from settling.
 4. Protect the edges of concrete slabs exposed by the removal of forms immediately with continuous curing treatment equal to the method selected for curing the pavement surface.
 - J. Curb and Gutter Construction:
 1. Construct curbs, or combined curb and gutter, where shown on the Contract Drawings along the edges of pavement; and form them to the cross-section indicated on the Contract Drawings or on State or municipal Standard Drawings.
 - a. Curbs may be constructed integrally with the pavement using slip-form or extrusion equipment, or placed immediately after finishing operations by hand forming or using face forms.
 - b. Alternatively, curbs may be constructed as a separate operation after pavement construction using forms, or slip-form or extrusion equipment.
 - c. If curb and gutter sections are built before the pavement is placed, the edge of each gutter of the curb and gutter section may be used as a side form in lieu of setting stationary side forms.
 - 1) Curb, or curb and gutter, constructed as a separate operation, must conform to the requirements of Section 02702, Concrete Curb, Gutter, Driveway, Sidewalk, and Alley Entrance.
 - d. Construct the curb and gutter sections to the same thickness as the main roadway section.
 - e. Align all joints in the curb and gutters with the roadway joints.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Pavement Thickness Test:
 - a. Test Procedure:
 - 1) Pavement thickness will be measured by the Testing and Inspection Agency in accordance with Section 401-4.04 of the ADOT Standard Specifications for Road and Bridge Construction.
 - 2) Where concrete cores have been removed, fill the holes with concrete as directed by the Program/Project Manager.
 - b. Acceptance Criteria:



- 1) Acceptance of the pavement will be in accordance with the criteria specified in Section 401-4.04 of the ADOT Standard Specifications for Road and Bridge Construction.
2. Inspections:
 - a. The pavement will be inspected for cracks.
 - b. Prepare and submit as-built information recording the actual depths and profiles of the pavement to the Program/Project Manager for information.
- B. Non-Conforming Work
 1. Either repair the pavement cracks discovered that penetrate the full depth of the pavement, or remove and replace the cracked pavement at no increase in Contract Price before opening the pavement to public traffic.
 - a. Repair cracks in accordance with the methods specified in Sections 401 and 402 of the ADOT Standard Specifications for Road and Bridge Construction as directed by the Program/Project Manager.

3.05 CLEANING

- A. At the completion of the pavement construction, remove all concrete forms, mixing and paving equipment, and traffic control devices furnished under this Section from the Site.

3.06 PROTECTION

- A. Protect exposed base or subgrade when equipment is cleaned at the end of each day's production.
 1. Remove concrete deposited on the base or subgrade immediately after the cleaning is completed.
- B. When ordered by the Program/Project Manager, construct pavement crossings for the convenience of public traffic.
 1. Where motor vehicles are encountered, provide a temporary bridge to span the newly placed concrete.
- C. Do not permit traffic or construction equipment, except as herein provided, on the concrete pavement until the concrete has developed a compressive strength of at least 3500 psi.
 1. Equipment for sawing joints is permitted on the concrete pavement if, in the Contractor's judgment, the concrete pavement has developed sufficient strength to support the equipment without damage to the concrete pavement.
 2. In case of visible cracking or other damage to the pavement, immediately discontinue operation of the equipment on the pavement.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 02761

PLASTIC PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cleaning and preparing the pavement surface.
 - 2. Requirements for furnishing the following:
 - a. White or yellow thermoplastic reflectorized pavement markings.
 - b. Preformed reflectorized pavement marking tape, symbols, and legends.
 - 3. Requirements for applying these pavement markings to the prepared pavement surface at the locations shown on the Contract Drawings in accordance with the details shown on the Contract Drawings, and in accordance with the requirements of the Federal Highway Administration's Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), the manufacturer's recommendations, and the requirements of the Specifications.
 - 4. Note that the plastic pavement markings specified herein are not permitted for airside applications.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01555 - Traffic Control.
 - 4. Section 02763 - Painted Pavement Markings.
 - 5. Section 02223 - Removal of Pavement Markings and Markers.

1.02 REFERENCES

- A. Definitions:
 - 1. Glass Beads or Glass Spheres: The terms "glass beads" is synonymous with "glass spheres" as used herein.
 - 2. Drying Time: The minimum elapsed time, after application, when a thermoplastic pavement marking will have and will retain the characteristics required herein and after which normal traffic will leave no impression or imprint on the newly applied marking.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M 247 - Standard Specification for Glass Beads Used in Traffic Paint.



- b. AASHTO T 250 - Standard Method of Test for Thermoplastic Traffic Line Material.
- 2. ASTM International (ASTM):
 - a. ASTM D 36 - Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus).
 - b. ASTM D 92 - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester.
 - c. ASTM D 476 - Standard Classification for Dry Pigmentary Titanium Dioxide Products.
 - d. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.
 - e. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
 - f. ASTM D 711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
 - g. ASTM D 1155 - Standard Test Method for Roundness of Glass Spheres.
 - h. ASTM D 1214 - Standard Test Method for Sieve Analysis of Glass Spheres.
- 3. Arizona Department of Transportation [ADOT]
 - a. ADOT Approved Products List.
 - b. ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices.
 - c. ADOT Materials Testing Manual.
 - d. ADOT Standard Specifications for Road and Bridge Construction.
 - e. ADOT Traffic Engineering Manual of Approved Signs (MOAS).
 - f. ADOT Standard Drawings –Signing and Marking Standards.
- 4. National Fire Protection Association (NFPA):
 - a. NFPA 385 Standard for Tank Vehicles for Flammable and Combustible Liquids.
- 5. U. S. Government:
 - a. Department of Transportation (DOT):
 - 1) Federal Highway Administration (FHWA):
 - a) FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.
 - b. General Services Administration (GSA):
 - 1) Federal Standards (FED-STD):
 - a) FED-STD-141/GEN - Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing (There are 105 individual standards available in the complete Federal Standard 141).
 - b) FED-STD-595B - Colors Volume 1.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:



1. Coordinate the Work of this Section with the appropriate State and municipal departments who own the Right-of-Way where the plastic pavement marking installation is to occur.

B. Sequencing:

1. Include provisions for traffic control during pavement marking operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the workers and the public.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Reflective glass beads.
 - b. Samples:
 - 1) Thermoplastic material, if requested.
 - 2) Drop-on beads, if requested.
 - 3) Primer-sealer, if requested.
 - c. Certificates:
 - 1) Certificates of Compliance for each type of preformed plastic pavement marking.
 - 2) Certificate of Compliance for each lot or batch of thermoplastic reflectorized material.
 - d. Special Procedure Submittals:
 - 1) Logbook of pavement surface temperatures for the thermoplastic pavement striping installations.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Reports:
 - 1) Certified test report for the thermoplastic material binder.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Right-of Way Owner Approvals:
 - a. Required approvals depend on who owns the right-of- way and where the plastic pavement markings are to be applied, but must be obtained before construction activities begin from the appropriate State and



municipal departments, which may include but are not limited to, the following:

- 1) Arizona Department of Transportation (ADOT).
 - 2) City of Phoenix Street Transportation Department.
 - 3) Phoenix Sky Harbor International Airport Design and Construction Services.
- b. If the owner of the Right-of-Way is other than the Phoenix Sky Harbor International Airport, the owner of the Right-of-Way will be provided on the Contract Drawings.
2. Approval of any type of marking material for use is subject to satisfactory performance under traffic.

B. Qualifications:

1. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections, the Phoenix Sky Harbor International Airport will employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
 - 1) Testing will be conducted in accordance with the latest AASHTO and ASTM test methods, Federal Standards, and the ADOT Materials Testing Manual as specified herein.

C. Certifications:

1. Submit a Certificate of Compliance for each type of preformed plastic pavement marking material prior to use.
2. Submit a Certificate of Compliance for each lot or batch of thermoplastic reflectorized material prior to use.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Notify the Program/Project Manager of the proposed sources of the materials provided under this Section prior to their delivery in order to expedite inspection and/or testing of the materials.
2. Properly package all materials to protect them from damage.
3. Clearly label each thermoplastic material container to indicate the following information:
 - a. Nature, type and formulation of the material, including whether it is an alkyd or hydrocarbon.
 - b. Manufacturer, batch number, and date of manufacture.
 - 1) Clearly mark the month and year of manufacture on all packages of thermoplastic material.
 - c. Application requirements and constraints.
 - d. Compatibility requirements and constraints, particularly those pertaining to equipment, storage, and other materials to be used.



- B. Storage and Handling Requirements:
 - 1. Properly store all materials to protect them from damage.
 - 2. Storage Life:
 - a. Provide new thermoplastic materials that will meet the requirements of the Specifications for a period of 1 year from the date of manufacture.
 - 1) Provide thermoplastic material that will melt uniformly with no evidence of skins or un-melted particles for this 1-year period.
 - 2) Do not use any material which does not meet the requirements, or which is no longer within this 1-year period at the time of application.
 - 3) Replace any outdated thermoplastic material with material meeting the performance and time requirements at no increase in Contract Price.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Pavement Temperatures:
 - a. For Preformed Pavement Markings:
 - 1) The pavement surfaces temperature at the time preformed pavement markings are applied must not be less than 60 degrees Fahrenheit, and the pavement surface must be absolutely dry.
 - a) For temporary markings, the weather conditions noted above may be waived at the Program/Project Manager's discretion to obtain a traffic stripe prior to allowing traffic to traverse the roadway.
 - b) Regardless of whether or not the required minimum surface temperature and surface condition are met, the Program/Project Manager may at any time require that work cease or that the work day be reduced due to weather conditions, either existing or expected, which would have an adverse affect upon the working conditions.
 - b. For Thermoplastic Pavement Marking:
 - 1) Measure pavement surface temperatures 1/2 hour prior to the start of the thermoplastic pavement striping installation and as deemed necessary by the Program/Project Manager until the end of the application period.
 - a) Measure the pavement surface temperature with a standard surface temperature thermometer or a non-contact infrared thermometer.
 - b) The lowest temperature measured will govern the work, unless otherwise requested by the Program/Project Manager.
 - c) At elevation changes greater than 1,000 feet, take temperature readings at the highest elevation and use them to



govern the work unless otherwise requested by the Program/Project Manager.

- d) Record the temperature measurements in a logbook, and submit them to the Program/Project Manager when requested.
- 2) For thermoplastic pavement marking application procedures other than for primer-sealer, the road surface temperature at the time of application must be a minimum of 55 degrees Fahrenheit and rising.
- 3) Do not use ribbon-gun application procedures for thermoplastic pavement markings if the wind chill factor is below 65 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Use only approved thermoplastic materials from manufacturers currently shown on the Arizona Department of Transportation's Approved Products List.
 - 1. The current ADOT Approved Products List is available from the Engineering Records Office, 1655 West Jackson Street, Phoenix, AZ 85007; (602) 712-8216; or online at <https://www.azdot.gov/docs/default-source/approved-products/apl.pdf?sfvrsn=14>

2.02 REGULATORY REQUIREMENTS

- A. Provide pavement markings conforming to the requirements of the following:
 - 1. FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.
 - 2. ADOT Arizona Supplement to the 2009 Manual on Uniform Traffic Control Devices
 - 3. ADOT Standard Drawings –Signing and Marking Standards.
 - 4. ADOT Traffic Engineering Manual of Approved Signs (MOAS).
- B. If the plastic pavement markings are within Arizona Department of Transportation (ADOT) right-of-way, comply with the material and construction requirements of the applicable Sections in the ADOT Standard Specifications for Road and Bridge Construction and Arizona Stored Specifications, and with the applicable ADOT Standard Drawings.

2.03 DESIGN CRITERIA

- A. Preformed Pavement Marking Tape, Symbols, and Legends:
 - 1. Provide the following preformed pavement marking tape, symbols, and legends designed for use in the following applications unless otherwise indicated in the Contract Drawings and/or specified:



2. Type I Preformed Pavement Markings - Permanent:
 - a. Design Type I preformed plastic pavement markings to be a general-purpose high durability retro-reflective pliant polymer film for preformed striping and markings to be used for finished permanent markings.
 - b. Design Type I preformed plastic pavement markings to be capable of performing as specified herein when subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover or encroachment on edge and channelization lines, starting, stopping, and turning movements.
 - c. Design the film to be weather resistant, and to show no appreciable fading, lifting, or shrinkage or significant tearing, roll back, or other signs of poor adhesion through normal traffic wear throughout the useful life of the marking.
 3. Type II Preformed Pavement Markings - Temporary Removable:
 - a. Design Type II preformed plastic pavement markings to be a removable preformed retro-reflective pavement marking capable of performing for the duration of a normal construction season.
 - b. Design Type II preformed plastic pavement markings to be weather resistant and show no appreciable fading, lifting, shrinkage, tearing, roll back, or other signs of poor adhesion through normal traffic wear throughout the useful life of the marking.
 - c. Design Type II preformed plastic pavement markings to be used on finished pavement surfaces, but to be removed prior to applying final pavement markings.
 - d. Design Type II preformed plastic pavement markings to be removable either manually or with a roll-up device at pavement temperatures above 40 degrees Fahrenheit without the use of heat, solvents, grinding, or sand blasting.
 4. Type III Preformed Pavement Markings - Temporary Non-Removable:
 - a. Design Type III preformed plastic pavement markings to be a non-removable preformed retro-reflective film on a conformable metallic backing capable of performing for the duration of a normal construction season.
 - b. Design Type III preformed plastic pavement markings to be weather resistant and show no appreciable fading, lifting, shrinkage, tearing, roll back or other signs of poor adhesion through normal traffic wear throughout the useful life of the marking.
 - c. Design Type III preformed plastic pavement markings to be used in construction zones where removal is unnecessary.
- B. Thermoplastic Pavement Marking Materials Selection and Compatibility:
1. The physical and chemical properties for thermoplastic pavement markings materials contained in this Specification apply regardless of the type of formulation used.
 2. Do not use incompatible materials together.

**2.04 MATERIALS:****A. Preformed Pavement Markings – Type I (Permanent):**

1. Provide preformed plastic pavement marking material consisting of a homogeneous, extruded, pre-fabricated white or yellow thermoplastic film of specified thickness and width that is capable of being permanently affixed to non-bleeding bituminous or Portland cement concrete.
 - a. Supply the plastic film either complete with pre-coated, factory-applied pressure sensitive adhesive backing covered by a protective release paper, or with adhesive separately applied as recommended by the manufacturer.
 - b. Whether the adhesive is pre-coated or supplied separately, provide adhesive that will allow the plastic film to be repositioned on the pavement surface to which it is applied before permanently fixing it in its final position with a downward pressure.
2. Supply plastic film of good appearance, free of cracks and discolorations, and with clean-cut and well defined the edges.
3. Composition:
 - a. Provide reflective glass beads uniformly distributed throughout the entire cross section and bonded to the top surface of the material.
 - b. Provide preformed plastic pavement marking Material consisting of the following components as shown in Table 02761-1.

Table 02761-1 Pavement Marking Material Components	
Component	Minimum Percent by Weight
Resins and Plasticizers	20
Pigments	30
Reflective Glass Beads	20

4. Physical Requirements:

- a. Color:
 - 1) Select and blend pigments to provide a white or yellow marking film that conforms to standard highway colors as specified in City standards or ADOT Standard Specifications for Road and Bridge Construction throughout the expected life of the film.
- b. Thickness:
 - 1) Provide 0.060 inch thick, minimum, extruded plastic film not including the adhesive.

B. Preformed Pavement Markings - Type II (Temporary - Removable):



1. Provide preformed plastic pavement marking material intended for marking applications where markings will be required to be removed.
 - a. Pre-coat the markings with a pressure sensitive adhesive capable of adhering to roadway surfaces under climatic and traffic conditions normally encountered in the construction work zone when applied in accordance with the manufacturer's instructions and without the use of heat, solvents, or other additional adhesives.
 - b. Provide temporary pavement markings capable of being removed manually or with a recommended roll up device from asphalt and concrete pavement either intact or in large sections by following the manufacturer's instructions.
 - 1) Use adhesive that permits visible adhesive residue remaining after removal of temporary pavement markings to be easily removed without the use of solvents or grinding and without damaging or scarring the pavement surface.
 2. Provide a mixture of good appearance, free of cracks, and with clean-cut and true, straight, and unbroken the edges.
 3. Provide temporary pavement markings capable of being immediately exposed to traffic without pickup or distortion by vehicles even when newly applied.
 4. Composition:
 - a. Provide a non-metallic mixture of high quality conformable materials and pigments.
 - b. Provide reflective glass beads uniformly distributed throughout the entire cross section and bonded to the top surface of the material.
 - 1) Provide glass beads that meet the durability and reflectance criteria specified in Section 02763, Painted Pavement Markings.
 5. Physical Requirements:
 - a. Color:
 - 1) Provide a white or yellow retro-reflective film that conforms to standard highway colors as specified in City standards or ADOT Standard Specifications for Road and Bridge Construction with glass beads in a reflective layer bonded to the top surface.
 - b. Thickness:
 - 1) Provide 0.045 inch thick, minimum, extruded pavement-marking material not including the adhesive.
- C. Preformed Pavement Markings – Type III (Temporary – Nonremovable)
1. Provide preformed plastic pavement marking material consisting of a retro-reflective film on a conformable metallic backing intended for marking applications where removal is not a requirement.
 - a. Pre-coat the markings with a pressure sensitive adhesive capable of adhering to roadway surfaces under climatic and traffic conditions normally encountered in the construction work zone when applied in accordance with the manufacturer's instructions and without the use of heat, solvents, or other additional adhesives.



2. Provide temporary pavement markings capable of being immediately exposed to traffic without pickup or distortion by vehicles even when newly applied.
3. Physical Requirements:
 - a. Color:
 - 1) Provide white or yellow markings that conform to standard highway colors as specified in City standards or ADOT Standard Specifications for Road and Bridge Construction and containing glass beads meeting the durability and reflectance criteria specified in Section 02763, Painted Pavement Markings.

D. Thermoplastic Reflectorized Material:

1. Provide thermoplastic reflectorized material consisting of a solid mixture of heat-stable resins to act as a binder, white or yellow pigment, inter-mixed glass beads, filler, and other materials in granular or block form specifically compounded for reflectorized pavement markings to be applied to the pavement in a molten state.
2. Thoroughly mix the ingredients into a solid or sectionalized block, or free-flowing granular form.
 - a. The material is to be free from all skins, dirt, and foreign objects.
 - b. Uniformly disperse the pigment, glass beads, and filler in the binder resin.
 - c. Comply with composition requirements of Table 02761-2.

Table 02761-2 Thermoplastic Reflectorized Material Composition		
Component	Percent by Weight	
	White	Yellow
Binder (hydrocarbon or alkyd)	18 to 25	18 to 26
Reflective glass inter-mix beads	30 to 40	30 to 40
Titanium Dioxide	10 to 15	---
Basic lead chromate	---	2 to 10
Calcium carbonate or equivalent filler	20 to 40	25 to 45

3. The material must be capable of complete and even coverage of specified areas with the required thickness when the proper application method and rate are used.

E. Thermoplastic Binder Material:

1. Base the composition of the thermoplastic material on one of the following two types:



- a. Hydrocarbon: Consisting mainly of synthetic petroleum hydrocarbon resins with appropriate fillers and pigments added.
 - b. Alkyd: Consisting of a mixture of synthetic resins, at least one of which is solid at room temperature, and of high-boiling-point plasticizers.
 - 1) At least one third of the binder composition and no less than eight percent by weight of the entire material formulation must be solid maleic-modified glycerol ester resin.
 - 2) The alkyd binder must not contain any petroleum-based hydrocarbon resins.
 - 2. Do not combine alkyd and hydrocarbon materials in thermoplastic pavement marking preparation or application equipment.
 - 3. Thoroughly clean thermoplastic pavement marking preparation and application equipment when materials are changed.
- F. Reflective Glass Beads (Pre-Mix):
- 1. Provide glass beads conforming to the requirements of AASHTO M 247 for Type 1, either coated or uncoated as recommended by the manufacturer; and exhibiting all of the properties specified herein.
 - a. Submit Product Data for the reflective glass beads.
 - 2. Manufacture glass beads from glass of a composition designated to be highly resistant to traffic wear and the effects of weathering.
 - a. Glass Bead color: Water white.
 - b. Provide glass beads free from air inclusions and scratches that might affect their function as a reflecting media.
 - 3. Provide glass beads essentially free of sharp angular particles, and not showing milkiness or surface scoring and scratching.
 - 4. Provide moisture-proof glass beads containing less than 0.25 percent moisture by weight and free of trash, dirt or other deleterious materials.
 - a. Moisture Proofing:
 - 1) During bead manufacture, apply a moisture-proof overlay consisting of water repellant material to all glass beads.
 - a) Provide an overlay treatment that prevents the beads from absorbing moisture in storage and keeps them free from clustering and lumping.
 - b) Provide an overlay treatment that assures the beads will flow freely from dispensing and testing equipment.
 - c) If uncoated beads are used, configure the thermoplastic formulation to minimize settling of the intermix beads when the material is heated and applied.
- G. Thermoplastic Reflectorized Material Filler:
- 1. Material:
 - a. White Calcium Carbonate, or equivalent:
 - 1) Compressive strength: 5000 pounds per square inch, minimum.
 - b. Titanium Oxide:



- 1) Conform to the requirements of ASTM D 476 for Type II (92 percent).
- H. Thermoplastic Reflectorized Material Pigment:
 1. Provide pigment consisting of silica double encapsulated heat resistant lead chromate.
- I. Thermoplastic Reflectorized Material Primer-Sealer:
 1. Provide primer-sealer compounded specifically for use with the specified thermoplastic material.

2.05 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. The Testing and Inspection Agency will conduct testing in accordance with the latest AASHTO and ASTM test methods, Federal Standards, and the ADOT Materials Testing Manual as specified herein.
 2. Type I Preformed Pavement Markings Acceptance Tests:
 - a. Bend Test:
 - 1) Test Method:
 - a) At a temperature of 78 to 82 degrees Fahrenheit, bend a 3-inch by 6-inch un-mounted piece of material (without adhesive and paper backing) over a 1-inch mandrel until the end faces are parallel and 1 inch apart.
 - 2) Acceptance Criteria:
 - a) The plastic film must be sufficiently flexible so it shows no fracture lines in the uppermost surface.
 - b. Tensile Strength:
 - 1) Test Method:
 - a) Test a 6-inch long by 1-inch wide specimen in accordance with the requirements of ASTM D 638.
 - b) Use a 0.25 inch per minute rate of pull.
 - c) Conduct the test at a temperature between 70 and 80 degrees Fahrenheit.
 - 2) Acceptance Criteria:
 - a) The plastic film (without adhesive or paper backing) must have a minimum tensile strength of 40 pounds per square inch.
 - b) The elongation may be no greater than 75 percent.
 - c. Plastic Pull Test:
 - 1) Test Method:
 - a) Suspend a dead load weight of four pounds from a 6-inch long by 1-inch wide section of the plastic film (without adhesive and paper backing).
 - b) Perform the test at a temperature between 70 and 80 degrees Fahrenheit.



- 2) Acceptance Criteria:
 - a) The section must support the weight for not less than five minutes.
- d. Abrasion Resistance:
 - 1) Test Method:
 - a) Abrade the plastic film according to FED-STD-141, Method 6192, using H-18 calibrase wheels with a 1000-gram load on each wheel for 500 revolutions.
 - 2) Acceptance Criteria:
 - a) The plastic film may have a maximum weight loss of 0.25 grams.
3. Thermoplastic Traffic Line Acceptance Tests:
 - a. Perform the acceptance testing specified in Subparagraphs 2.05.A.4, 2.05.A.5, and 2.05.A.6; and the following:
 - 1) Make a small trial batch prior to making the thermoplastic traffic line in large quantities to make certain the finished product will comply with all the requirements of this Section.
 - 2) For acceptance testing, do not use a batch size of thermoplastic striping material less than 1,360kg (3000 pounds) unless the total order is less than this amount.
4. Thermoplastic Reflectorized Material Tests:
 - a. Melt Test:
 - 1) Test Method:
 - a) Heat thermoplastic reflectorized material in a melting apparatus to the molten application temperature.
 - 2) Acceptance Criteria:
 - a) The material must readily liquefy into a uniform solution free from all skins, dirt, foreign objects, or any other ingredient that would cause bleeding, staining, blotting, or discoloration when applied to the bituminous or concrete pavement surfaces.
 - b) The material cannot exude toxic fumes which are injurious to persons or property.
 - c) The material must remain stable when held for 4 hours at the temperature range specified by the manufacturer, or when subjected to reheating up to 4 times, not exceeding a total of 4 hours, after cooling to ambient temperature.
 - (1) The temperature viscosity characteristics of the plastic material must remain constant throughout the reheating and will show like characteristics from batch to batch.
 - (2) There can be no obvious change in color of the thermoplastic material as a result of reheating, and the color of the material cannot vary from batch to batch.



- d) Upon cooling to normal pavement temperature, this material must produce an adherent reflectorized marking capable of resisting deformation and wear in the roadway.
- 5. Thermoplastic Binder Material Tests:
 - a. Color:
 - 1) Test Procedure:
 - a) After heating for four hours at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit and cooled to 77 degrees Fahrenheit plus or minus 3 degrees Fahrenheit, the material must meet the following requirements:
 - 2) Acceptance Criteria:
 - a) White:
 - (1) Daylight reflectance at 45 degrees - 0 degrees: 75 percent minimum.
 - (2) The color must match FED-STD-595B, Color Chip No. 17925.
 - b) Yellow:
 - (1) Daylight reflectance at 45 degrees - 0 degrees: 45 percent minimum.
 - (2) The color must match FED-STD-595B, Color Chip No. 13538.
 - b. Retro-Reflectance:
 - 1) Test Procedure:
 - a) 30 Days after application of the thermoplastic material to the roadway surface, measure the retro-reflectance of white and yellow thermoplastic materials at 86.5 degrees illumination angle and 1.5 degrees observation angle using a Mirolux 212 portable retro-reflectometer.
 - 2) Acceptance Criteria:
 - a) Provide white and yellow thermoplastic materials with the minimum retro-reflectance values as shown in Table 02761-3.

Table 02761-3 White and Yellow Thermoplastic Material Retro-Reflectance	
Thermoplastic Color	Retro-Reflectance (Millicandles)
White	200
Yellow	150

- c. Water Absorption:
 - 1) Test Method:
 - a) Determine the water absorption of the thermoplastic material in accordance with the requirements of ASTM D 570.



- 2) Acceptance Criteria:
 - a) The thermoplastic material may not absorb water exceeding 0.5 percent, by weight, or retain water.
- d. Specific Gravity:
 - 1) Test Method:
 - a) Determine the specific gravity of the thermoplastic material in accordance with the requirements of Section 11 of AASHTO T 250.
 - 2) Acceptance Criteria:
 - a) The specific gravity of the material must be between 1.85 and 2.3.
- e. Drying Time:
 - 1) Test Procedure:
 - a) Apply material having a thickness of 0.125 inches at a temperature of 425 degrees Fahrenheit, and measure the time the material takes to set.
 - 2) Acceptance Criteria:
 - a) Material that is set to bear traffic in not more than 2 minutes when the air temperature is 50 degrees Fahrenheit and in not more than 15 minutes when the air temperature is 90 degrees Fahrenheit. Is acceptable.
- f. Bond Strength:
 - 1) Test Method:
 - a) Determine the bond strength of the thermoplastic material in accordance with the requirements of Section 7 of AASHTO T 250.
 - b) Heat the thermoplastic material for four hours at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - 2) Acceptance Criteria:
 - a) The bond strength to Portland cement concrete must not be less than 0.18 ksi.
- g. Low Temperature Crack Resistance:
 - 1) Test Method:
 - a) Determine the low temperature crack resistance of the thermoplastic material in accordance with the requirements of Section 8 of AASHTO T 250.
 - b) Heat the thermoplastic material for four hours plus or minus 5 minutes at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - c) Apply the material to concrete blocks.
 - d) Cool the material and blocks to 15 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - 2) Acceptance Criteria:
 - a) The material must show no cracks when observed from a distance not exceeding 1 foot.



- h. Impact Resistance:
 - 1) Test Method:
 - a) Determine the impact resistance of the thermoplastic material in accordance with the requirements of Section 9 of AASHTO T 250.
 - b) Heat the thermoplastic material for 4 hours plus or minus 5 minutes at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - c) Form test specimens and run the test.
 - 2) Acceptance Criteria:
 - a) The material impact resistance must be not less than 10 inch pounds.
- i. Softening Point:
 - 1) Test Method:
 - a) Determine the softening point of the thermoplastic material in accordance with the requirements of ASTM D 36.
 - b) Heat the thermoplastic material for four hours plus or minus 5 minutes at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - 2) Acceptance Criteria:
 - a) The material softening point must not be less than 215 degrees Fahrenheit plus or minus 15 degrees Fahrenheit.
- j. Yellowness Index:
 - 1) Test Method:
 - a) Determine the yellowness index of the white thermoplastic material in accordance with the requirements of Section 4 of AASHTO T 250.
 - b) Acceptance Criteria:
 - (1) The white thermoplastic material must not exceed a yellowness index of 0.12.
- k. Flowability (Extended Heating):
 - 1) Test Method:
 - a) Determine the extended heating flowability of the thermoplastic material in accordance with the requirements of Section 12 of AASHTO T 250.
 - b) Heat the thermoplastic material for 8-1/2 hours plus or minus 5 minutes at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - c) Stir the material for the last six hours and then test for flowability.
 - 2) Acceptance Criteria:
 - a) Thermoplastic material having 28 percent residue, maximum, is acceptable.
- l. Flowability:
 - 1) Test Method:



- a) Determine the extended heating flowability of the thermoplastic material in accordance with the requirements of Section 6 of AASHTO T 250.
 - b) Heat the thermoplastic material for 4 hours plus or minus 5 minutes at 425 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - c) Test for flowability.
 - 2) Acceptance Criteria:
 - a) White thermoplastic: 18 percent residue, maximum.
 - b) Yellow thermoplastic: 21 percent residue, maximum.
 - m. Abrasion Resistance:
 - 1) Test Method:
 - a) Apply a suitable primer to a four-inch square monel panel that is 0.050-inch thick plus or minus 0.001 inch.
 - b) Form a 0.125-inch thick representative lot of the material on the monel square.
 - c) Subject the material on the monel square to 200 revolutions on a Taber Abraser at 25 degrees Celsius using H-22 calibrated wheels weighted to 250 grams.
 - d) Keep the wearing surface wet with distilled water throughout the test.
 - 2) Acceptance Criteria:
 - a) The maximum loss of thermoplastic material must not exceed 0.5 grams.
 - n. Flash Point:
 - 1) Test Method:
 - a) Determine the flash point of the thermoplastic material in accordance with the requirements of ASTM D 92.
 - 2) Acceptance Criteria:
 - a) Thermoplastic material having a flash point of 475 degrees Fahrenheit, minimum, is acceptable.
 - o. Submit a verifiable certified test report from the thermoplastic material binder manufacturer showing the acceptability of the binder system as specified; including an infrared spectra of the extracted binder compared to the characteristic absorption bands of maleic-modified glycerol ester of wood resin.
- 6- Reflective Glass Beads (Pre-Mix) Tests:
- a. Index of Refraction Test
 - 1) Test Procedure:
 - a) Test beads by a liquid immersion method at a temperature of 25 degrees Celsius.
 - 2) Acceptance Criteria:
 - a) Beads must have an index of refraction of 1.50 to 1.57.
 - b. Glass Bead Roundness Test:
 - 1) Test Procedure:



- a) Test glass beads in accordance with ASTM D 1155, Procedure B except delete paragraphs F and G.
- 2) Acceptance Criteria:
 - a) Glass beads retained on any screen specified in the gradation requirements are to contain a minimum of 70 percent true spheres.
- c. Glass Bead Moisture Test:
 - 1) Test glass beads for compliance with specification requirements for moisture proofing using the following procedure or an approved alternate.
 - 2) Test Procedure:
 - a) Conduct the test at a temperature of 25 plus or minus 1 degree Celsius and a relative humidity of 50 plus or minus 5 percent.
 - b) Weigh 900 grams of glass beads into a clean, dry, flat-bottomed pan.
 - c) Dry the beads at 150 degrees Celsius for 2 hours.
 - d) Cool the beads to room temperature of 25 degrees plus or minus 1 degree Celsius in a desiccator.
 - e) Wash an unbleached cotton bag in hot water and detergent.
 - (1) Provide a 10-1/2 inch by 17-1/2 inch bag sewn into an L-shape and having a fabric thread count of 48 by 48.
 - (2) Turn the bag inside out so that the sewn seam-allowance is on the outside
 - f) Place the quantity of glass beads into the inverted cotton bag
 - g) Gather the top of the bag and lower it into a container of distilled water until the beads are approximately 25 millimeters below the water level.
 - (1) Use a container having sufficient dimensions so that the bag does not contact the sides or bottom during immersion.
 - (2) Immerse each bag individually.
 - (3) Do not allow one bag to contact another if multiple tests are run.
 - h) Remove the bag after 30 seconds of immersion time.
 - i) Twist the top neck of the bag until the twisted bag is compressed firmly against the beads.
 - (1) Continue twisting the bag until excess water no longer drips from the bag.
 - j) After the excess water has been squeezed from the bag, allow the bag to unwind.
 - k) Gather and clamp the top of the bag.
 - l) Suspend the bag on a ring stand or other support so that the bottom or sides of the bag do not contact the support.



- m) After two hours at room temperature of 25 degrees Celsius, plus or minus 1 degree, remove the bag from the support.
- n) Mix the sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, inverting the bag, and shaking it up and down 5 times.
- o) Transfer the sample into a clean, dry standard laboratory funnel with a top opening diameter of 125 millimeters, a 150-millimeter stem length, and inside stem diameter between 9 and 10 millimeters.
 - (1) If consecutive tests are run, be sure the funnel is clean and free of beads from prior tests.
- 3) Acceptance Criteria:
 - a) The entire glass bead sample must flow through the funnel without stoppage.
 - (1) At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.
 - (2) Small quantities of beads adhering to the side of the funnel or stem are not cause for failure.
- d. Glass Bead Gradation:
 - 1) Test Procedure:
 - a) Test the gradation of the glass beads in accordance with the procedures described in ASTM D 1214.
 - 2) Acceptance Criteria:
 - a) Provide beads containing the percentages of each size bead as allowed by Table 02761-4.

Table 02761-4 Glass Bead Gradation	
Size of Sieve	Percent Passing
Number 30	100
Number 50	15 to 35
Number 70	0 to 15
Number 100	0 to 5

- e. Specific Gravity:
 - 1) Test Procedure:
 - a) Place 100 grams of beads in an oven at 110 degrees Celsius for one hour.
 - b) Remove the beads and place them in a desiccator until the sample is cool.
 - c) Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately on a balance accurate to 0.1 grams.



- d) Measure the volume of the sample:
 - (1) Pour the beads slowly into a clean 100-millimeter graduated cylinder containing 50 millimeters of isopropyl alcohol making sure there is no air trapped among the beads.
 - (2) The total volume, minus 50, will give the volume of the beads.
- e) Calculate the specific gravity as follows:

$$\text{Specific Gravity} = \frac{\text{Weight of the Sample}}{\text{Volume of the Sample}}$$

- 2) Acceptance Criteria:
 - a) The specific gravity of the beads must be in the range from 2.40 to 2.60.
- f. Chemical Stability:
 - 1) Prior to acceptance, glass beads that show a tendency toward decomposition, including surface etching when exposed to atmospheric conditions, moisture, dilute acids, or alkalis or paint film constituents, may be required to demonstrate satisfactory reflectance behavior when subjected to such tests as may be prescribed.
- g. Chemical Resistance:
 - 1) Test Procedure:
 - a) Place three to five gram portions of the sample in each of 3 Pyrex glass beakers or porcelain dishes.
 - b) Cover one sample with distilled water, one with a 3N solution of sulfuric acid, and the third with a 50 percent solution of sodium sulfide.
 - c) After one hour of immersion, microscopically examine the glass beads of each sample for evidence of darkening and frosting.
 - 2) Acceptance Criteria:
 - a) Glass beads must withstand immersion in water and acids with no noticeable corrosion, etching, darkening, or otherwise noticeable decomposition caused by the sulfides.
- 7. Inspections:
 - a. Thermoplastic material, drop-on beads, and primer-sealer must be inspected and approved by the Program/Project Manager before their application.
 - 1) Submit Samples of thermoplastic material, drop-on beads, and primer-sealer if requested by the Program/Project Manager.

B. Non-Conforming Work:

- 1. Do not apply non-conforming materials.



2. Evidence of adulteration or improper formulation of thermoplastic pavement marking material is cause for rejection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Perform a field inspection to determine if the striping exceeds the Contract's construction limits.
- B. Evaluation and Assessment:
 1. It is possible that the required striping may exceed the Contract's construction limits in order to match and/or tie into the existing striping.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
 - a. Provide the necessary personnel and equipment to divert traffic from the installation area where Work is in progress and during curing time when, in the opinion of the Program/Project Manager, diversion of traffic is necessary.
- B. Surface Preparation:
 1. Thoroughly clean pavement surfaces of loose, foreign, or other material that may adversely affect bonding.
 2. Remove all dirt, dust, grease, oil, and other detrimental material from the road surface by sweeping and using a high-pressure air spray.
 - a. The method of cleaning the surface and removal of detrimental material is subject to approval by the Program/Project Manager, including sweeping and the use of high-pressure air spray.
 3. Newly placed surfaces where preformed plastic pavement marking will be applied do not need to be cleaned unless, in the opinion of the Program/Project Manager, the surface has become contamination.
 4. Where thermoplastic pavement markings will be applied, prepare the surface in accordance with the recommendations of the thermoplastic material manufacturer prior to application of thermoplastic stripes, arrows, legends, or symbols.
 - a. Remove loose material, including all grindings and obliterated markings, from the pavement surface and properly dispose of this material.
 - b. Scrub any area that cannot otherwise be satisfactorily cleaned with a biodegradable Citrus Solv Plus, or approved equal.



- c. If thermoplastic markings are to be applied to new Portland cement concrete pavement, remove any curing compound by means of a high-pressure water jet or sand blasting, followed by sweeping and high-pressure air spray.
 - 1) Remove the curing compound at least 2 inches beyond the entire perimeter of each marking to be installed.
5. Layout of Work:
 - a. Spot mark the proposed locations of striping at 10-foot intervals in conformance with the striping indicated on the Contract Drawings and layout pavement markings for the entire Contract.
 - 1) Layout lane widths, parking spaces, and crosswalks in accordance with the regulations of the Authorities Having Jurisdiction and as indicated on the Contract Drawings.
 - 2) Position pavement markings as defined on the Contract Drawings and in the Specifications.
6. Upon completion of the spot marking, notify the Program/Project Manager that the spot marking is ready for inspection.
7. The Program/Project Manager will complete an inspection of the proposed striping within the 3 working days after notification.
 - a. If a conflict exists between the actual field conditions and the pavement marking plans on the Contract Drawings, cease working and notify the Program/Project Manager immediately.
 - b. If it becomes necessary for proper installation, the Program/Project Manager may revise individual marking locations.
 - c. Do not apply the plastic pavement markings without the approval of the Program/Project Manager.
 - 1) Approval of the spot marking does not relieve the Contractor from obtaining a final inspection.
8. After installing asphalt concrete pavement, allow a cooling down period of at least 12 hours prior to the installation of thermoplastic pavement markings.
9. On Portland cement concrete and existing hot mix asphaltic concrete surfaces, use primer-sealers prior to application of thermoplastic material.
 - a. Apply primer-sealers as recommended by the thermoplastic material manufacturer.
 - b. Application of primer-sealer is not required on newly placed hot-mix asphaltic concrete surfaces prior to application of the thermoplastic Material.
10. When primer-sealer and thermoplastics are applied, the road surface must be absolutely dry with no detectable or measurable surface or near-surface dampness.
 - a. If precipitation or other surface wetting is imminent, stop all marking operations.
 - b. If any surface dampness is detected during marking activities, stop marking operations until the pavement dries.



C. Demolition/Removal:

1. If pavement marking or marker obliteration is necessary, perform this work in accordance with the requirements of Section 02223, Removal of Pavement Markings and Markers.
 - a. Complete removal of existing pavement markings prior to the spot marking the locations of new plastic pavement markings.

3.03 APPLICATION

A. Preformed Plastic Pavement Marking:

1. Apply preformed pavement markings immediately after the surface has been prepared, or as soon as possible after placement and completion of new pavement.
2. Install preformed pavement markings at the locations shown on the Contract Drawings, or as directed by the Program/Project Manager.
 - a. Use Type I preformed plastic pavement markings for finished permanent markings that will be subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover or encroachment on edge and channelization lines, starting, stopping, and turning movements.
 - b. Use Type II preformed plastic pavement markings on finished pavement surfaces where traffic control or channelization through a construction zone is temporary requiring removal prior to application of final pavement markings.
 - c. Use Type III preformed plastic pavement markings in construction zones where removal is unnecessary due to placement of future paving courses or where pavement will be removed, obliterated, or abandoned at the completion of the Contract.
3. Apply preformed pavement markings in accordance with the recommendations of the manufacturer of the material and these Specifications
 - a. Minor changes in procedures recommended may be allowed if they are shown to produce an equal or better application and are approved by the Program/Project Manager.
 - b. Apply preformed marking tape manually or with the tape applicators approved by the tape manufacturer.
 - c. Only use butt splices and do not overlap preformed marking material.
 - d. Do not apply preformed pavement markings over other markings or old paint unless that is specified in the Contract Drawings or directed by the Program/Project Manager.
4. Thoroughly tamp all preformed markings with approved mechanical tampers.

B. Thermoplastic Pavement Markings:

1. Equipment:



- a. Provide preparation and application equipment in accordance with the Specifications and conforming to the recommendations of the materials manufacturer.
 - 1) Use equipment with controls located in such a position to enable full visibility of the striping apparatus.
 - 2) Use mobile and maneuverable application equipment that can follow straight lines and can make normal curves in a true arc.
 - 3) Application equipment for roadway installations may include truck-mounted units, motorized ride-on equipment, or manually pushed equipment depending on the type of marking required.
 - a) Equip the truck-mounted units with high-pressure air spray jets in front of the pavement marking material applicators to remove loose matter from the pavement surface where the marking material is to be applied.
 - b) Use truck-mounted or motorized ride-on units for center lines, lane lines, and edge lines that consist of a mobile self-contained unit carrying its own material and capable of operating at a minimum speed of five miles per hour while applying striping.
 - c) Use hand applicator equipment capable of applying material both longitudinally and transversely.
 - (1) Use hand applicator units with either self-contained melters or reservoirs that are filled from a separate melter unit.
 - (a) Either type of unit must be able to maintain and measure the required application temperatures.
 - (2) Use only hand applicator equipment sufficiently maneuverable to install symbols, legends, and curved and straight lines.
- b. Use equipment designed to provide continuous uniform heating at temperatures exceeding 400 degrees Fahrenheit while mixing and agitating the material to install hot applied thermoplastic material.
 - 1) Use equipment with a special kettle for uniformly melting and heating the thermoplastic material.
 - a) The heating kettle and application equipment must comply with the requirements of NFPA 385, the State, and local authorities.
 - b) Equip the heating mechanism of the kettle with a heat transfer medium consisting of oil or air.
 - c) Do not allow the burner flame to directly contact the material vessel surface.
 - 2) Provide functioning and calibrated temperature sensing devices for melting and application equipment to verify that the temperature requirements are being met.



- a) Equip the kettle with 2 temperature gauges, one to indicate the temperature of the oil or air heat transfer medium and the other to indicate the temperature of the thermoplastic material.
 - b) Equip the kettle with an automatic thermostatic control device that allows for positive temperature control to prevent overheating or under heating the material.
 - c) Submit proof that the temperature sensing devices and thermometers are fully functional upon request from the Program/Project Manager.
 - d) Use equipment with a mixing and agitating mechanism capable of thoroughly mixing the material at a rate, which ensures constant uniform temperature distribution.
 - e) Use equipment that operates all mixing and conveying parts, including the line-dispensing device, while maintain the material at the plastic temperature.
- c. Configure the conveying portion of the equipment, between the main material reservoir and the line-dispensing device, to prevent accumulation and clogging, and to maintain the material at the specified application temperature.
- 1) Use equipment whose parts that come in contact with the material are designed for easy accessibility for cleaning and maintenance.
- d. Use application equipment designed to assure continuous uniformity in the dimensions of the pavement marking.
- 1) Use an applicator having a means for cleanly cutting off square pavement marking edges and providing a method of applying "skip" and solid lane lines.
 - 2) Use equipment capable of varying the widths and thicknesses of pavement markings.
 - a) Use extrusion, ribbon, or spray dispensing devices capable of applying the required shape and thickness.
 - 3) If screed or extrusion application of thermoplastic is allowed by the Program/Project Manager for short applications, use the screed/extrusion application method wherein one side of the shaping die is the pavement and the other three sides are contained by equipment suitable for heating or controlling the flow of material.
 - 4) Do not use pans, aprons, or similar appliances which the dispenser overruns.
- e. Equip thermoplastic melting units, trucks, or trailers with foam-type fire extinguishers suitable for application to thermoplastic material that is at the flash point.
- f. Use an automatic glass bead dispenser attached to the striping machine so that a glass bead top dressing is applied to the completed molten thermoplastic material immediately after it has been applied to the pavement.



- 1) For truck-mounted or motorized ride-on units, use pressure-type spray gun bead dispensers, and for hand applicators use a drop-on bead dispenser.
 - 2) Use bead dispensers capable of evenly distributing glass beads at the required application rate immediately after the application of the thermoplastic.
 - 3) Use bead dispenser that embeds the beads in the surface of the molten thermoplastic at an anchoring depth of from 55 to 60 percent of the bead diameter.
 - 4) Equip the bead dispenser with an automatic cut-off synchronized with the cut-off of the thermoplastic material.
2. Placement and Location:
 - a. Position pavement markings as shown on the Contract Drawings and described in the Specifications.
 - 1) Individual marking locations may be revised by the Program/Project Manager if it becomes necessary for proper installation or to accommodate the following requirements:
 - a) Do not place marking lines on parallel construction or expansion joints.
 - b) Offset longitudinal lines to provide 2 to 4 inches of clearance from parallel construction and expansion joints unless otherwise directed by the Program/Project Manager.
 - c) Offset longitudinal lines at least 12 inches clear of construction joints, unless otherwise requested by the Program/Project Manager.
 - d) Avoid placing symbols and legends on construction joints, expansion joints, or uneven pavement surfaces.
 - 2) Identify locations where construction joints, expansion joints, or otherwise unsuitable surfaces conflict with the specified locations for symbols or legends so that the Program/Project Manager can designate new locations for such symbols or legends.
3. Primer-Sealer Application:
 - a. If recommended by the manufacturer, use a primer-sealer on both old and new Portland cement concrete pavement.
 - 1) Apply the primer-sealer at the manufacturer's recommended application rates prior to placing the thermoplastic material.
 - 2) Allow the primer-sealer to cure for the manufacturer's specified cure or evaporation time so it will be free of solvent and water when the thermoplastic is applied.
 - 3) If epoxy primer is used, complete the thermoplastic application before the epoxy has cured.
 - b. Apply the thermoplastic material to the primed pavement surfaces within the working time specified by the primer-sealer and thermoplastic materials manufacturers.



- 1) If the primed surfaces are not marked within the specified time limits, re-prime the surfaces as required by the manufacturer at no increase in Contract Price.
- c. Improper primer-sealer application may result in bond failure between the thermoplastic and the pavement surface and may cause the thermoplastic surface to pinhole or blister.
 - 1) Should bond failure, pinholing, or blistering occur, stop all application operations until the cause is determined and corrected, and remove and replace all defective markings at no increase in Contract Price.
4. Thermoplastic and Glass Bead Application:
 - a. Note the start of the heating time for each batch of thermoplastic material in the temperature log and on the side of the kettle to which it applies.
 - 1) Unless otherwise requested by the Program/Project Manager, monitor the temperature of the material at 30-minute intervals and maintain a log of the temperature readings.
 - 2) Take readings at the melting kettle or the application outlet point, as determined by the Program/Project Manager.
 - b. Maintain specified temperature requirements at all times during the application.
 - 1) Material temperatures for applying alkyd and hydrocarbon thermoplastic cannot exceed 450 degrees Fahrenheit at any time.
 - 2) Temperatures exceeding 440 degrees Fahrenheit may be allowed for short periods of time; however, do not hold the material above 440 degrees Fahrenheit in any case for more than 4 hours.
 - 3) Do not allow total heating time for any batch of material to exceed 6 hours.
 - c. Extrude or spray thermoplastic pavement marking material on to the pavement surface.
 - 1) If the hot-applied thermoplastic marking blisters upon application, stop marking operations until the cause, potentially including surface moisture, is determined and corrected.
 - 2) Provide uniform thermoplastic thickness consistent throughout the total length of the marking required.
 - a) Perform periodic spot checks of the thermoplastic material to verify that the required thickness has been attained.
 - b) Spot check procedures include the following:
 - (1) For wet thermoplastic:
 - (a) Field test the thickness immediately after applying the thermoplastic marking by inserting a thin, graduated machinist rule or similar instrument into the molten thermoplastic to the depth of the pavement surface.



- (b) Determine the thickness visually by noting on the scale the depth of the penetration or coating on the instrument.
 - (2) For dry thermoplastic:
 - (a) Field test the thickness by placing a small flat sheet of metal with a thickness known to be the same as the required thermoplastic thickness immediately ahead of the striping apparatus, and compare depths.
 - (b) After striping, remove a sample and use a suitable measuring device, such as a caliper or micrometer, to determine the thickness of the dried marking.
- d. Minimize the thermoplastic material remaining in the kettle at the end of each workday, and blend a minimum of 80 percent of fresh material into the kettle at the start of each day.
 - 1) During delays and subject to specified limits on total acceptable heating time for each batch, transfer heated thermoplastic Material into approved containers for later re-use.
- e. Mechanically deposit drop-on glass beads at the specified rate into the thermoplastic material immediately after the thermoplastic marking is applied.
 - 1) Use the bead dispenser to evenly distribute the beads so that they embed in the surface of the thermoplastic as specified.
 - 2) If the glass beads do not adhere to the thermoplastic marking, stop the operation until the problem has been corrected.
 - 3) Remove and replace markings which do not meet the specified requirements as determined by the Program/Project Manager at no increase in Contract Price.
- f. Longitudinal Pavement Markings:
 - 1) Either an alkyd or a hydrocarbon thermoplastic formulation may be used for longitudinal lines, including lane lines and edge lines, unless otherwise shown on the Contract Drawings or specified herein.
 - a) Place 60-mil (0.060 inch) thick hot-sprayed thermoplastic reflectorized final striping within 7 to 14 calendar days after completion of the final pavement surface, or as directed by the Program/Project Manager.
 - b) Apply all other markings at the same time.
 - 2) Use spray formulations in accordance with requirements of the application equipment used to install the markings.
- g. Transverse Pavement Markings:
 - 1) Use an extruded alkyd thermoplastic formulation for all transverse lines, including stop bars and crosswalks.
 - 2) Place 90-mil (0.090 inch) extruded thermoplastic reflectorized striping final striping at the same time as all other markings as directed by the Program/Project Manager.



- 3) Use extrusion formulations in accordance with requirements of the application equipment used to install the markings.

C. Tolerances:

1. Provide finished thermoplastic lines free from waviness and having well defined edges.
2. Lateral deviation of the thermoplastic stripe: 1.0 inch in 100 feet maximum.
3. The longitudinal deviation of a painted segment and gap must not vary more than 6 inches in a 40-foot cycle.
4. The actual width of stripe must be within the limits specified in Table 02761-5, according to the width of stripe called for on the Contract Drawings:

Table 02761-5 Tolerances for Stripe Width	
Drawing Width	Actual Width
4 inches	4 to 4-1/2 inches
8 inches	8 to 9 inches
Over 8 inches	Plus or minus 1.0 inch

3.04 REPAIR/RESTORATION

- A. Maintain temporary preformed plastic pavement markings or replace them when necessary until they are covered with the next overlay course or are removed because they are no longer applicable.
- B. Immediately remove temporary preformed plastic pavement markings when they are no longer needed for traffic control or when they are in conflict with the succeeding traffic pattern.
 1. Remove pronounced markings across lanes, transitions, or tapers caused by the adhesive.
 2. Remove preformed pavement markings using methods recommended by the manufacturer and approved by the Program/Project Manager.
 3. Do not bum or grind off removable temporary marking material.
 4. Immediately remove residual adhesive, ghosting, shadows, or pavement scarring which might cause confusion during darkness or adverse weather conditions when so ordered by the Program/Project Manager.
- C. Immediately repair any failure during the time frame the preformed plastic material is scheduled to perform.
- D. Continued failure of a preformed plastic material to perform is cause for disallowing further use of that particular manufacturer's material.



3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. The Testing and Inspection Agency will conduct testing in accordance with the latest AASHTO and ASTM test methods, Federal Standards, and the ADOT Materials Testing Manual as specified herein.
2. Thermoplastic Marking Tests:
 - a. Test Procedure:
 - 1) Apply thermoplastic material within a temperature range of 412.5 degrees Fahrenheit plus or minus 12.5 degrees Fahrenheit at a thickness of between 60 to 90 mils to pavement.
 - 2) The Program/Project Manager may conduct field tests in accordance with ASTM D 711 to verify actual drying times.
 - b. Acceptance Criteria:
 - 1) The material must set to bear traffic in not more than 2 minutes when the air and road surface temperature is approximately 50 degrees Fahrenheit plus or minus 3 degrees Fahrenheit, and not more than 10 minutes when the air and road surface temperature is approximately 90 degrees Fahrenheit plus or minus 3 degrees Fahrenheit.
 - 2) After application and sufficient drying time, the thermoplastic marking must show no appreciable deformation or discoloration under local traffic conditions in an air and/or road temperature ranging from minus 10 degrees Fahrenheit to 180 degrees Fahrenheit.
3. Inspections:
 - a. Perform daily maintenance and operation inspections of all application equipment to ensure that it is operable within the requirements of the Specifications.
 - 1) Inform the Program/Project Manager of any equipment breakdowns, intermittent malfunctions, or other conditions that may impact the proper application of the specified markings.
 - 2) Repair or replace any equipment judged to be unsuitable by the Program/Project Manager.
 - b. The final striping inspection will be made by the Program/Project Manager within 3 Days after all pavement markings and markers have been installed.

B. Non-Conforming Work

1. Failure of materials, inadequate marking characteristics, or any other confusing or unsafe condition in a construction work zone will not be tolerated.
2. Failure of any particular type of marking material to satisfactorily adhere to the pavement or to be satisfactorily removable is reason for disallowing its use.



3. Immediately correct all misalignments when ordered to do so by the Program/Project Manager.
 - a. Remove and reinstall the misaligned portions in accordance with the Specifications.

3.06 SYSTEM STARTUP

- A. All areas marked with preformed marking tape must be ready for traffic immediately after application.

3.07 WASTE MANAGEMENT

- A. Dispose of excess materials, cleaning fluids, and empty material containers offsite in conformance with the State and Federal requirements.

3.08 PROTECTION

- A. If so ordered by the Program/Project Manager, remedy any condition where the safety of workmen or the traveling public might be endangered.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition





SECTION 02763

PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cleaning and preparing the pavement surface.
 - 2. Requirements for providing pavement markings consisting of white, yellow, red, black, and blue water-borne, lead-free, rapid-dry traffic paint and reflective glass beads at the locations and in accordance with the details shown on the Contract Drawings, the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), and the requirements of the Specifications, or as directed by the Program/Project Manager.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01555 - Traffic Control.
 - 4. Section 02223 - Removal of Pavement Markings and Markers.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. MSDS: Material Safety Data Sheet.
- B. Definitions:
 - 1. Glass Beads or Glass Spheres: The terms "glass beads" is synonymous with "glass spheres" as used herein.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
 - a. The U.S. Environmental Protection Agency has composed the following definition for regulatory, not necessarily scientific, purposes: "VOC means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions (and then lists several other exemptions)."
- C. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):



- a. AASHTO M 247 – Standard Specification for Glass Beads Used in Traffic Paints.
2. American Concrete Institute (ACI):
 - a. ACI 503R – Use of Epoxy Compounds with Concrete.
3. ASTM International (ASTM):
 - a. ASTM D 93 - Standard Test Methods for Flash Point by Penske-Martens Closed Cup Tester.
 - b. ASTM D 562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer.
 - c. ASTM D 711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
 - d. ASTM D 713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials.
 - e. ASTM D 913 - Standard Test Method for Evaluating Degree of Resistance to Wear of Traffic Paint.
 - f. ASTM D 1155 - Standard Test Method for Roundness of Glass Spheres.
 - g. ASTM D 1210 - Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage.
 - h. ASTM D 1214 - Standard Test Method for Sieve Analysis of Glass Spheres.
 - i. ASTM D 1475 - Standard Test Method for Density of Liquid Coatings, Inks, and Related Products.
 - j. ASTM D 1640 - Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature.
 - k. ASTM D 2243 - Standard Test Method for Freeze-Thaw Resistance of Water-Borne Coatings.
 - l. ASTM D 2369 - Standard Test Method for Volatile Content of Coatings.
 - m. ASTM D 2486 - Standard Test Methods for Scrub Resistance of Wall Paints.
 - n. ASTM D 2621 - Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints.
 - o. ASTM D 3723 - Standard Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing.
 - p. ASTM D 3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
 - q. ASTM D 4414 - Standard Practice for Measurement of Wet Film Thickness by Notched Gages.
 - r. ASTM E 70 - Standard Test Method for pH of Aqueous Solutions With the Glass Electrode.
 - s. ASTM G 154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
4. Arizona Department of Transportation (ADOT):



- a. ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices.
- b. ADOT Materials Testing Manual.
- c. ADOT Standard Drawings –Signing and Marking Standards.
- d. ADOT Standard Specifications for Road and Bridge Construction.
- 5. U. S. Government:
 - a. Federal Aviation Administration (FAA):
 - 1) Aviation Administration Advisory Circulars (FAA AC):
 - a) FAA AC No. 150/5340-1J – Standards for Airport Markings.
 - b. Department of Transportation (DOT):
 - 1) Federal Highway Administration (FHWA):
 - a) FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.
 - 2) Pipeline and Hazardous Materials Safety Administration:
 - a) 49 CFR 173 Shippers-General Requirements for Shipments and Packagings.
 - c. Environmental Protection Agency (EPA):
 - 1) 40 CFR 51 Requirements for Preparation, Adoption, and Submittal of Implementation Plans.
 - d. General Services Administration (GSA):
 - 1) Federal Specifications (FS):
 - a) FS TT-P-1952 - Paint, Traffic and Airfield Marking, Waterborne.
 - b) FS TT-B-1325 – Beads (Glass Spheres) Retro-Reflective.
 - 2) Federal Standards (FED-STD):
 - a) FED-STD-141/GEN - Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing.
 - b) FED-STD-595B - Colors Volume 1.
 - e. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the Work of this Section with the appropriate State and municipal departments who own the Right-of-Way where the painted pavement markings are to be applied.
- B. Sequencing:
 - 1. Include provisions for traffic control during pavement marking operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the workers and the public.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pavement marking paint.
 - 2) Reflective glass beads.
 - 3) Material Safety Data Sheets (MSDS) for the pavement marking paint.
 - b. Samples:
 - 1) Verification samples from each lot or batch of material for each paint formulation not certified by a Certificate of Compliance for testing.
 - 2) Samples from each lot or batch of material for reflective glass beads.
 - c. Certificates:
 - 1) Certificate of Compliance (in lieu of verification samples) for each single component paint formulations.
 - 2) Manufacturer's Certification that the pavement marking paint does not contain hazardous materials as defined in Section 1200 of 29 CFR 1910.
 - d. Qualification Statements:
 - 1) Pertinent work experience of the applicator personnel.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Right-of Way Owner Approvals:
 - a. Required approvals depend on who owns the right-of- way and where the painted pavement markings are to be applied, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - 1) Arizona Department of Transportation (ADOT).
 - 2) City of Phoenix Streets Department.
 - 3) Phoenix Sky Harbor International Airport Design and Construction Services.
 - b. If the owner of the Right-of-Way is other than the Phoenix Sky Harbor International Airport, the owner of the Right-of-Way will be provided on the Contract Drawings.
2. U.S. Environmental Protection Agency Requirements:
 - a. Only provide paint which complies with the low volatile organic compound (VOC) requirements as defined in 40 CFR 51.100,



Requirements for Preparation, Adoption, and Submittal of Implementation Plans.

3. Notify the Program/Project Manager of any change in pavement marking paint formulation.
 - a. The Program/Project Manager must approve any change in the formulation of the paint.

B. Qualifications:

1. Applicator Qualifications:

- a. Only allow personnel who are experienced in this type of work to place traffic marking.
- b. Submit pertinent work experience of the applicator personnel to the Program/Project Manager for approval.

C. Certifications:

1. Submit a Certificate of Compliance for each single component paint formulation that certifies the material complies with the requirements specified herein to the Program/Project Manager for approval.
 - a. Submit Certificates of Compliance for each lot or batch of material prior to its use.
 - b. Certify that material complies with each test specified for the material.

D. Sustainability Standards Certifications:

1. Submit the manufacturer's Certification that the pavement marking paint does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolysable chlorine derivatives, ethylene-based glycol ethers and their acetates, and not any carcinogen, as defined in Section 1200, Hazard Communication, of 29 CFR 1910.
 - a. Lead content must not exceed 0.06 percent of weight of the dry film.
 - b. Test for chromium content must be negative.

E. Preconstruction Testing:

1. If an acceptable Certificate of Compliance for each single component paint formulation and/or an acceptable Certificate of Analysis for each lot or batch of reflective glass beads is not provided, submit paint and/or bead test samples to the Program/Project Manager for testing by the Testing and Inspection Agency specified in Section 01400, Quality Requirements, to verify the materials comply with the requirements specified in Article 2.03.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. One Component Pavement Marking Paint:
 - a. Packaging:



- 1) All shipping containers for paint must comply with the requirements of 49 CFR 173, particularly Section 173.24, General Requirements for Packagings and Packages.
 - 2) Provide containers and lids lined with a suitable coating to prevent attack of the paint by agents in the air space above the paint.
 - a) The lining must not come off the container or lid as skins.
 - 3) Provide containers colored white, including the lids; and include an identifying band of the appropriate color around and within the top one third of the container.
 - 4) Properly seal the containers with suitable gaskets.
 - 5) Provide containers showing no evidence of leakage.
 - 6) Provide containers capable of remaining in satisfactory condition for a period of 12 months after delivery to a distributor or paint applicator.
- b. Labeling:
- 1) Label the paint containers on both the side of the container and on the lid to show the manufacturer's name, date of manufacture, paint color, product code, manufacturer's batch number, and quantity or weight of paint.
 - 2) Clearly mark or label containers as either rapid or fast dry, lead-free water-borne traffic paints.
 - 3) Label the paint containers to indicate that the contents fully comply with all rules and regulations concerning air pollution control in the State of Arizona and Maricopa County.
 - 4) The manufacturer of the paint is responsible for attaching proper shipping labels indicating whether the contents are toxic, corrosive, flammable, or as otherwise required by 49 CFR 173, particularly Section 173.24, Shippers Responsibility.
- B. Storage and Handling Requirements:
1. Single Component Pavement Marking Paint:
 - a. Access to Paint Storage:
 - 1) If single component pavement marking paint is shipped to a distributor or paint applicator for storage prior to application, the distributor or paint applicator must allow the Program/Project Manager or his designee free access to the facility where the paint is stored and provide every reasonable facility for sampling the paint.
 2. Unused Paint:
 - a. Package paint that is to be saved for later use as specified, and ship it to a storage location.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
1. Moisture Conditions:



- a. Apply painted and dual component pavement markings only when the pavement surface is dry and the weather is not foggy, rainy, or otherwise adverse to the application of markings.
- b. Do not apply water-borne paints if rain is expected within 1 hour of application, unless otherwise approved by the Program/Project Manager.
2. Temperature Conditions:
 - a. Do not apply water-borne paints when the atmospheric temperature is below 50 degrees Fahrenheit, or when it can be anticipated that the atmospheric temperature will drop below 50 degrees Fahrenheit during the drying period.
 - b. Apply dual component pavement markings only when the atmospheric temperature is a minimum of 40 degrees Fahrenheit and rising, and do not apply them if the wind chill factor is below 35 degrees Fahrenheit.
 - 1) Measure the surface temperature 1/2 hour prior to the start of striping operations, and every 1 to 2 hours thereafter if requested by the Program/Project Manager.
 - 2) Use standard surface temperature or infrared non-contact thermometers for measuring the temperatures.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS:

- A. Provide pavement markings conforming to the requirements of the following:
 1. FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.
 2. ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices
 3. ADOT Standard Drawings –Signing and Marking Standards.
- B. If the painted pavement markings are within Arizona Department of Transportation (ADOT) right-of- way, comply with the material and construction requirements of the applicable Sections in the ADOT Standard Specifications for Road and Bridge Construction and Arizona Stored Specifications, and with the applicable ADOT Standard Drawings.
- C. If the painted pavement markings are within airport runways, taxiways, or aprons, comply with the requirements specified in FAA AC No. 150/5340-1J.

2.02 MATERIALS

- A. Pavement Marking Paint:
 1. Pavement Marking Paint:



- a. Provide ready-mixed, single component traffic line paint of the correct color(s) for application to either asphalt or Portland cement concrete pavement.
 - b. Formulate one component pigmented water-borne paint in a consistent manner containing all the necessary co-solvents, dispersant, wetting agents, preservatives and all other additives, so that the paint retains its viscosity, stability, and all of the properties as specified herein.
 - 1) Provide well ground paint pigments properly dispersed in the paint vehicle.
 - 2) Provide pigment that does not cake or thicken in the container and that does not become granular or curdled.
 - 3) Any settlement of the pigment in the paint must result in a thoroughly wetted, soft mass, permitting the complete and easy vertical penetration of a paddle.
 - a) Settled pigment must be easily re-dispersed, with minimum resistance to the sideways manual motion of a paddle across the bottom of the container, to form a smooth product of the proper consistency.
 - b) If the settled pigment cannot be easily re-dispersed, due to excessive pigment settlement as described above or due to any other cause, the paint will be considered unfit for use.
 - c. Provide paint free from foreign materials such as dirt, sand, fibers from bags, or other materials capable of clogging screens, valves, pumps and other equipment used in a paint striping apparatus.
 - d. Provide paint that retains all specified properties under normal storage conditions for 12 months after acceptance and delivery.
 2. All manufactured paint prepared at the factory must be ready for application.
 3. Manufacturers:
 - a. 3M, www.3m.com.
 - b. Ennis Traffic Safety Solution, www.ennistraffic.com.
 - c. Approved equal.
 4. Submit Product Data and Material Safety Data Sheets (MSDS) for the single component water-borne pavement marking paint to the Program/Project Manager for approval.
- B. Reflective Glass Beads for Pavement Marking Paint:
1. For pavement markings not on the airfield, provide glass beads conforming to the requirements specified for Type 1 beads in AASHTO M 247, either coated or uncoated as recommended by the manufacturer; and exhibiting all of the properties specified herein.
 - a. Provide glass beads essentially free of sharp angular particles, and not showing milkiness or surface scoring and scratching.
 - b. Manufacture glass beads from glass of a composition designated to be highly resistant to traffic wear and the effects of weathering.
 - c. Glass Bead color: Water white.



- d. Provide glass beads free from air inclusions and scratches that might affect their function as a reflecting media.
- e. Glass Bead Moisture Proofing:
 - 1) Provide moisture-proof glass beads containing less than 0.25 percent moisture by weight and free of trash, dirt or other deleterious materials.
 - a) During bead manufacture, apply a moisture-proof overlay consisting of water repellant material to all glass beads.
 - (1) Provide an overlay treatment that prevents the beads from absorbing moisture in storage and keeps them free from clustering and lumping.
 - (2) Provide an overlay treatment that assures the beads will flow freely from dispensing and testing equipment.
- 2. For pavement markings on the airfield, provide glass beads conforming to the requirements specified for Type III beads in FS TT-B-1325, either coated or uncoated as recommended by the manufacturers of the paint and reflective glass beads.
- 3. Submit Product Data for the reflective glass beads to the Program/Project Manager for approval.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. If an acceptable Certificate of Compliance for each single component paint formulation and/or an acceptable Certificate of Analysis for each lot or batch of reflective glass beads is not provided, the Testing and Inspection Agency will conduct verification testing on samples submitted in accordance with the latest ASTM test methods, Federal Test Method Standard No. 141, and the ADOT Materials Testing Manual, as specified herein:
- 2. Pavement Marking Paint Qualitative Requirements:
 - a. Color:
 - 1) Test Procedure:
 - a) Provide black paint having a color closely matching FED-STD-595B, Color Chip No. 37038.
 - b) Provide blue paint having a color closely matching FED-STD-595B, Color Chip No. 35180.
 - c) Provide green paint having a color closely matching FED-STD-595B, Color Chip No. 34090.
 - d) Provide red paint having a color closely matching FED-STD-595B, Color Chip No. 31136.
 - e) Provide white paint having a color closely matching FED-STD-595B, Color Chip No. 37925.
 - f) Provide yellow paint having a color closely matching FED-STD-595B, Color Chip No. 33538 or 33655.
 - g) Visually check the color against Tristimulus Values for the color according to FED-STD-141.



- 2) Acceptance Criteria:
 - a) Colors matching the specified color are acceptable.
- b. Dry Opacity:
 - 1) Test Procedure:
 - a) Determine dry opacity for the paint using a black-white Lenata Chart, Form 2C Opacity and a Photovolt 577 Reflectance Meter or equal.
 - b) Using a 10-mil gap doctor blade, draw down a film of paint, covering both black and white portions of the chart.
 - (1) Dry the film for 24 hours.
 - (2) After calibrating the Reflectance Meter according to the manufacturer's instructions, measure the reflectance over the white and black portions with the green Tristimulus filter.
 - (3) Calculate dry opacity as follows:

$$\text{Dry Opacity} = \frac{\text{Reflectance over black}}{\text{Reflectance over white}}$$

- 2) Acceptance Criteria:
 - a) Dry Opacity for both white and yellow paint: 0.90, minimum.
- c. Yellowness Index:
 - 1) Test Procedure:
 - a) Determine the yellowness Index for white paint as described for dry opacity, except use a 15-mil gap doctor blade to draw down the paint.
 - b) After 24 hours for drying, measure the reflectance of the paint film, using green, blue, and amber Tristimulus filters.
 - c) Calculate the Yellowness Index as follows:

$$\text{Yellow Index} = \frac{\text{Amber} - \text{Blue}}{\text{Green} \times 100}$$

- 2) Acceptance Criteria:
 - a) Yellowness Index for the white paint: 10, maximum.
- d. Reflectance:
 - 1) Test Procedure:
 - a) Determine reflectance for both white and yellow paint using the same 15-mil drawdown film as for the Yellowness Index.
 - (1) For white paint, the same sample may be utilized for both the yellowness index and reflectance.
 - (2) Measure the reflectance of the paint film using the green Tristimulus filter.
 - 2) Acceptance Criteria:
 - (1) Reflectance for the white paint: 85, minimum.



- (2) Reflectance for the yellow paint: Within a range from 42 to 59, inclusive.
- e. UV Color Durability:
 - 1) Test Procedure:
 - a) Determine UV Color Durability using a QUV Weatherometer, with ultra violet light and condensate according to ASTM G 154, for 300 hours total.
 - b) Use a repeating cycle of four hours UV exposure at 60 degrees Celsius followed by four hours condensate exposure at 40 degrees Celsius.
 - 2) Acceptance Criteria:
 - a) After 300 hours of exposure, the yellowness index for white paint must not exceed 12, and yellow paint must still match FED-STD-595B, Color No. 33538.
- f. Static Heat Stability:
 - 1) Test Procedure:
 - a) Place one pint of paint in a sealed can and heat in an air circulation oven at 120 degrees Fahrenheit plus or minus 1 degree Fahrenheit for a period of one week.
 - b) Remove the paint from the oven and check the viscosity in Krebs Units at 77 degrees Fahrenheit plus or minus 1 degree Fahrenheit according to ASTM D 562.
 - 2) Acceptance Criteria:
 - a) The viscosity measured must be in the range from 68 to 90, inclusive.
 - b) Also, check for any signs of instability.
- g. Heat Shear Stability:
 - 1) Test Procedure:
 - a) Shear one pint of paint in a Waring blender at high speed to 150 degrees Fahrenheit.
 - (1) Use a blender having tight fitting lid taped onto it to minimize volatile loss.
 - b) When the paint reaches 150 degrees Fahrenheit, stop the blender, immediately pour the paint into a sample can, and apply a cover to seal the can.
 - c) Let the paint cool overnight, and examine for jelling or other signs of instability.
 - d) Measure its viscosity in Krebs Units at 77 degrees Fahrenheit plus or minus 1 degree Fahrenheit according to ASTM D 562.
 - 2) Acceptance Criteria:
 - a) The viscosity measured must be in the range from 68 to 95, inclusive.
 - b) If the viscosity measured is not within the upper limit, run total solids on the sheared paint and adjust solids, if necessary, by adding water to reach the original solids content.



- (1) If the solids content requires adjustment, check the viscosity of the paint again.
 - (a) The viscosity must be in the range from 68 to 95, inclusive.
- h. Scrub Resistance:
 - 1) Test Procedure:
 - a) Determine scrub resistance in accordance to ASTM D 2486.
 - b) Use an appropriate doctor blade to provide a dry film thickness of 3 to 4 mils.
 - c) Allow the paint to cure for 24 hours.
 - d) Perform the scrub resistance test at 77 degrees Fahrenheit plus or minus 1 degree Fahrenheit and 50 percent plus or minus 5 percent humidity.
 - e) Record the number of cycles to remove the paint film.
 - 2) Acceptance Criteria:
 - a) The number of cycles must be a minimum of 800.
- i. Spraying Properties:
 - 1) Test Procedure:
 - a) Apply paint providing a 15-mil wet film thickness in the field.
 - 2) Acceptance Criteria:
 - a) The paint must show the following properties at ambient temperatures of 50 to 100 degrees Fahrenheit with a paint spray temperature of 150 degrees Fahrenheit, maximum; and 6 to 8 pounds of post-applied glass beads per gallon of paint:
 - (1) Dry to a no-track condition in five minutes or less when the line is crossed over in a passing maneuver with a standard-sized automobile.
 - (2) Produce a clean-cut, smooth line with no overspray or puddling.
 - (3) Accept glass beads immediately after application so that the spheres will be embedded into the paint film to a depth of 50 percent of their diameter.
 - (4) When heated to the temperature necessary to obtain the specified dry time, show no signs of instability, such as viscosity increase, jelling, or poor spray application.
- j. Freeze-Thaw Properties:
 - 1) Test Procedure:
 - a) Test the paint for freeze-thaw resistance by subjecting it to 5 cycles of according to the requirements of ASTM D 2243.
 - 2) Acceptance Criteria:
 - a) The paint viscosity may not change significantly.
- k. Road Service Rating:
 - 1) Test Procedure:



- a) Apply 4 inch wide paint test stripes approximately 12 feet long transversely across the road at a location approved by the Program/Project Manager.
 - b) Provide test stripes with a wet film thickness of approximately 15-mils as determined according to ASTM D 4414 and ASTM D 713.
 - (1) To aid in obtaining the correct film thickness, a length of roofing paper placed by the side of the road prior to test stripe application can be used.
 - (a) Place a rigid metal test panel on the roofing paper in the path of a test line.
 - (b) Immediately after the test stripe is applied, measure the wet film thickness.
 - (c) If it is not satisfactory, adjust the spray pressure and repeat this process until the target wet fill thickness is attained.
 - (2) It is important that no glass beads be present that would give a false wet film thickness.
 - c) Determine the initial bead retention using the following samples:
 - (1) When the wet film thickness is correct, apply a test line across a tarred metal test panel.
 - (2) After this, apply another test line across a different tarred metal test panel and add the glass beads.
 - (a) Apply the glass beads after the paint has been applied, but during the same striping operation, and at a rate so that the initial bead retention on the test line is a minimum of 6 pounds of beads per gallon of wet paint.
 - (b) Ensure that the glass bead spheres are embedded into the paint film to a depth of 50 percent of their diameter.
- 2) Acceptance Criteria:
- a) Evaluate paints for wear according to ASTM D 913.
 - (1) Observe test stripes for a period of 180 Days from the date of application, and take all rating measurements in the wheel track area.
 - (a) Determine bead loss by taking close-up photographs of the paint film and counting the average bead loss.
 - (b) Glass beads may show no more than a 30 percent loss after 180 Days of the test to be acceptable.
 - (c) After 180 Days of service, paints must have a rating of 92 percent or better on a visual rating scale of 0 to 100 percent to be acceptable.



- b) At the option of the Program/Project Manager, the road service rating test may be waived or evaluated for a period of time less than 180 Days.
3. Pavement Marking Paint Quantitative Requirements:
- a. Provide one component water-borne pavement marking paint complying with the quantitative requirements listed in Table 02763-1.

Table 02763-1 Quantitative Requirements of Mixed Paints		
Property	Test Method	Quantitative Requirement
Pigment: Percent by weight, allowable variation from qualifying sample.	ASTM D 3723	±2.0
Non-volatile Content: Percent by weight, allowable variation from qualifying sample.	ASTM D 2369	±2.0
Viscosity: Krebbs Units at 77°±1°F.	ASTM D 562	80 to 95
Weight per Gallon: Pounds per gallon at 77°± 1°F, allowable variation from qualifying sample.	ASTM D 1475	±0.3
Vehicle Composition: Vehicle infrared spectra, allowable variation from qualifying sample.	ASTM D 2621	None
pH: Allowable variation from qualifying sample.	ASTM E 70	±1.0
Fineness of Dispersion: HEGMAN, minimum.	ASTM D 1210	3.0
Volatile Organic Compounds (VOC): Pounds per gallon of paint, maximum.	ASTM D 3960 according to 10.2.1	2.1
Flash Point: °F, minimum.	ASTM D 93, Method A	100
Dry Time to No Pick Up: With no beads, minutes, maximum.	ASTM D 711	10



Table 02763-1 Quantitative Requirements of Mixed Paints		
Property	Test Method	Quantitative Requirement
Dry Through Time: Minutes.	ASTM D 1640, except do not apply thumb pressure when rotating thumb 90 degrees on the paint film.	20
Flexibility:	FS TT-P-1952	Pass

4. Reflective Glass Bead Qualitative Requirements:
 - a. Reflective Glass Bead Index of Refraction Test:
 - 1) Test Procedure:
 - a) Test beads by a liquid immersion method at a temperature of 25 degrees Celsius.
 - 2) Acceptance Criteria:
 - a) Beads must have an index of refraction of 1.50 to 1.57.
 - b. Reflective Glass Bead Roundness Test:
 - 1) Test Procedure:
 - a) Test glass beads in accordance with ASTM D 1155, Procedure B except delete paragraphs F and G.
 - 2) Acceptance Criteria:
 - a) Glass beads retained on any screen specified in the gradation requirements are to contain a minimum of 75 percent true spheres.
 - c. Reflective Glass Bead Moisture Test:
 - 1) Test Procedure:
 - a) Test glass beads for compliance with specification requirements for moisture proofing using the following procedure or an approved alternate.
 - b) Conduct the test at a temperature of 25 plus or minus 1 degree Celsius and a relative humidity of 50 plus or minus 5 percent.
 - c) Weigh 900 grams of glass beads into a clean, dry, flat-bottomed pan.
 - d) Dry the beads at 150 degrees Celsius for 2 hours.
 - e) Cool the beads to room temperature of 25 degrees plus or minus 1 degree Celsius in a desiccator.
 - f) Wash an unbleached cotton bag in hot water and detergent.
 - (1) Provide a 10-1/2 inch by 17-1/2 inch bag sewn into an L-shape and having a fabric thread count of 48 by 48.



- (2) Turn the bag inside out so that the sewn seam-allowance is on the outside.
 - g) Place the quantity of glass beads into the inverted cotton bag
 - h) Gather the top of the bag and lower it into a container of distilled water until the beads are approximately 25 millimeters below the water level.
 - (1) Use a container having sufficient dimensions so that the bag does not contact the sides or bottom during immersion.
 - (2) Immerse each bag individually.
 - (3) Do not allow one bag to contact another if multiple tests are run.
 - i) Remove the bag after 30 seconds of immersion time.
 - j) Twist the top neck of the bag until the twisted bag is compressed firmly against the beads.
 - (1) Turn the bag inside out so that the sewn seam-allowance is on the outside.
 - (2) Continue twisting the bag until excess water no longer drips from the bag.
 - (3) After the excess water has been squeezed from the bag, allow the bag to unwind.
 - (4) Gather and clamp the top of the bag.
 - k) Suspend the bag on a ring stand or other support so that the bottom or sides of the bag do not contact the support.
 - l) After two hours at room temperature of 25 degrees Celsius, plus or minus 1 degree, remove the bag from the support.
 - m) Mix the sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, inverting the bag, and shaking it up and down 5 times.
 - n) Transfer the sample into a clean, dry standard laboratory funnel with a top opening diameter of 125 millimeters, a 150-millimeter stem length, and an inside stem diameter between 9 and 10 millimeters.
 - (1) If consecutive tests are run, be sure the funnel is clean and free of beads from prior tests.
- 2) Acceptance Criteria:
- a) The entire glass bead sample must flow through the funnel without stoppage.
 - (1) At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.
 - (2) Small quantities of beads adhering to the side of the funnel or stem are not cause for test failure.
- d. Reflective Glass Bead Gradation:



- 1) Provide beads containing the percentages of each size bead as allowed by Table 02763-3 when tested in accordance with ASTM D 1214.

Table 02763-3 Gradation of Reflective Glass Beads (for One Component Pavement Marking Paint)	
Size of Sieve	Percent Passing
No. 30	100
No. 50	15 to 35
No. 70	0 to 15
No. 100	0 to 5

e. Reflective Glass Bead Specific Gravity:

1) Test Procedure:

- a) Place 100 grams of beads in an oven at 110 degrees Celsius for one hour.
- b) Remove the beads and place them in a desiccator until the sample is cool.
- c) Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately on a balance accurate to 0.1 grams.
- d) Measure the volume of the sample:
 - (1) Pour the beads slowly into a clean 100-millimeter graduated cylinder containing 50 millimeters of isopropyl alcohol making sure there is no air trapped among the beads.
 - (2) The total volume, minus 50, will give the volume of the beads.
- e) Calculate the specific gravity as follows:

$$\text{Specific gravity} = \frac{\text{Weight of the sample}}{\text{Volume of the sample}}$$

2) Acceptance Criteria:

- a) The specific gravity of the beads must be in the range from 2.40 to 2.60.

f. Reflective Glass Bead Chemical Stability:

- 1) Prior to acceptance, glass beads that show a tendency toward decomposition, including surface etching when exposed to atmospheric conditions, moisture, dilute acids, or alkalis or paint



film constituents, may be required to demonstrate satisfactory reflectance behavior when subjected to such tests as may be prescribed by the Program/Project Manager.

g. Reflective Glass Bead Chemical Resistance:

1) Test Procedure:

- a) Place 3 to 5 gram portions of the sample in each of 3 Pyrex glass beakers or porcelain dishes.
- b) Cover one sample with distilled water, one with a 3N solution of sulfuric acid, and the third with a 50 percent solution of sodium sulfide.
- c) After one hour of immersion, microscopically examine the glass beads of each sample for evidence of darkening and frosting.

2) Acceptance Criteria:

- a) Glass beads must withstand immersion in water and acids with no noticeable corrosion, etching, darkening, or otherwise noticeable decomposition caused by the sulfides

5. Inspections:

- a. Advise the Program/Project Manager when paint is to be manufactured and furnish free access to all parts of the plant involved in manufacturing the paint for the purpose of sampling both the paint and the raw Materials during manufacturing.
 - 1) Materials used in product formulation must meet the requirements of this Specification.
 - 2) Materials not specifically specified must receive the approval of the Program/Project Manager.

B. Non-Conforming Work:

1. Do not use non-conforming materials for the Work of this Contract.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Layout of Work:

- a. Spot mark the proposed locations of striping for the entire Contract at 10-foot intervals in conformance with the striping indicated on the Contract Drawings.
 - 1) Layout lane widths, parking spaces, and crosswalks in accordance with the regulations of the Authorities Having Jurisdiction and as indicated on the Contract Drawings.
 - b. Position pavement markings as defined on the Contract Drawings and in the Specifications.
2. Upon completion of the spot marking, notify the Program/Project Manager that the spot marking is ready for inspection.



3. The Program/Project Manager will complete an inspection of the proposed striping within the 3 working days after notification.
 - a. If it becomes necessary for proper installation, the Program/Project Manager may revise individual marking locations.
 - 1) It is possible that the required striping may exceed the Contract's construction limits in order to match and/or tie into the existing striping.
 - a) A field inspection will determine if the striping exceeds the Contract's construction limits.
 - b. Do not apply the paint without the approval of the Program/Project Manager.
 - 1) Approval of the spot marking does not relieve the Contractor from obtaining a final inspection.

B. Pre-Installation Testing:

1. Paint will normally be sampled at the place of storage or at the Site prior to application of the paint.
 - a. Notify the Program/Project Manager a minimum of 14 Working Days prior to any traffic painting operation to allow access at that time for paint sampling at the storage location.
 - b. Furnish a minimum of 1 paint Sample from each lot of paint.
 - c. At the time of paint application and at intervals determined by the Program/Project Manager, furnish samples of paint to the Program/Project Manager.

C. Evaluation and Assessment:

1. If a conflict exists between the actual field conditions and the pavement marking on the Contract Drawings, cease working and notify the Program/Project Manager immediately.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
 - a. Provide the necessary personnel and equipment to divert traffic from the installation area where Work is in progress and during drying time when, in the opinion of the Program/Project Manager, diversion of traffic is necessary.

B. Surface Preparation:

1. Verify that the pavement surface is free from excess asphalt or deleterious substances before traffic paint, beads, or primer are applied.
 - a. Remove all dirt, debris, grease, oil, rocks, and chips from the pavement surface before applying markings.



- b. Scrub areas with a biodegradable chemical that cannot otherwise be satisfactorily cleaned.
 - c. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Program/Project Manager including sweeping and the use of high-pressure air spray.
 - 2. If a seal is required, allow a sufficient drying time (48 hours minimum) before applying any pavement markings.
 - a. If after the 48 hours drying time has passed the seal remains tacky or excessive oil has risen to the roadway surface, apply a sand blotter to absorb the excess oil.
 - b. If the seal remains tacky, no pavement marking may be applied.

C. Demolition/Removal:

- 1. Removal existing pavement markings and markers in accordance with the requirements of Section 02223, Removal of Pavement Markings and Markers.
 - a. Prior to spot marking the proposed locations of striping as specified in Subparagraph 3.01.A.1, complete the removal of existing pavement markings.

3.03 APPLICATION

A. Equipment:

- 1. Place pavement marking (traffic) paint and beads on the pavement using a spray-type, self-propelled pavement marking machine.
 - a. Temporary striping during construction may be placed with other equipment designed for application of paint and beads with the approval of the Program/Project Manager.
 - 2. Provide application equipment for roadway installation having, at a minimum, the following characteristics and/or apparatus:
 - a. Capability to apply clear-cut lines of the width specified on the Contract Drawings.
 - b. A mechanical device capable of placing a broken reflectorized line with a 10-foot painted segment and a 30-foot gap.
 - c. An air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.
 - 1) Use a glass bead dispenser, capable of placing the glass beads into the paint line as the paint is applied to the pavement
 - 2) No glass beads are allowed in the pavement marking paint before the paint is applied.
 - a) Apply glass beads after the paint has been applied.

B. Applying Paint and Beads:

- 1. Unless otherwise indicated, apply painted pavement markings having the dimensions required by the Authorities Having Jurisdiction and as indicated on the Contract Drawings.



- a. Unless otherwise indicated, provide 4-inch wide pavement stripes.
 - b. Provide median ends (bull-noses) in accordance with ADOT Standard Drawing No. M-1.
 - c. Provide stop bar marking in accordance with ADOT Standard Drawing No. M-6.
 2. Initially apply the lane lines, edge lines, centerlines, crosswalks, and stop bars required under this Contract within 2 days of placing the final lift of asphalt or concrete pavement, or as directed by the Program/Project Manager.
 3. 30 to 45 days after the initial lane lines, edge lines, centerlines, crosswalks, and stop bars required under this Contract were applied, restripe these items throughout the entire Contract Site; and at the same time apply the symbols, transverse markings, and other markings remaining to be applied as indicated on the Contract Drawings or in the Specifications.
 4. Application Rates:
 - a. For Pavement Markings Not on the Airfield:
 - 1) Based on a 10-foot stripe and a 30-foot gap (40-foot cycle), apply pavement marking paint at the following rates for the type of pavement marking indicated:
 - a) Solid 4-inch line: 16 gallons per mile.
 - b) Broken 4-inch line: 4 gallons per mile.
 - 2) Apply glass reflectorizing beads onto the wet paint at a minimum rate of 6 pounds of beads for each gallon of paint.
 - b. For Airfield Pavement Markings:
 - 1) Apply pavement marking paint at a rate of 115 square feet for each gallon of paint.
 - 2) Apply glass reflectorized beads onto wet paint at a minimum rate of 10 pounds of beads for each gallon of paint.
 5. Wet Thickness:
 - a. Apply pavement marking paint to achieve a wet thickness not less than 15 mils.
 6. Do not allow the paint to bleed, curl, or discolor while it is applied to the roadway surface.
 7. Do not heat water-borne paint to a temperature greater than 150 degrees Fahrenheit to accelerate drying.
- C. Tolerances:
1. Length:
 - a. Do not allow the length of a painted segment and gap to vary more than 6 inches in a 40-foot cycle.
 2. Width:
 - a. Provide 4-inch, 8-inch, or 12-inch wide painted lines as shown on the Contract Drawings with a tolerance of plus or minus 1/8-inch.
 3. Alignment:



- a. Do not allow new pavement striping to vary from the striping alignment indicated on the Contract Drawings more than 1/2-inch in 50 feet.
- 4. Re-striping:
 - a. When existing pavement markings require re-striping, completely cover existing markings to within 1/4-inch and within a longitudinal tolerance of 6 inches at the beginning and at the end of each stripe.

3.04 REPAIR

- A. If bleeding, curling, or discoloration occurs, apply additional coats of paint to the unsatisfactory areas to correct the problem.
 - 1. In the event the additional coats of paint are insufficient, the Program/Project Manager will determine what method of correction may be used.
- B. If a sand blotter is applied after the installation of pavement markings to absorb excess paint, remove all marking affected and re-applied it.
- C. Make repairs and corrections at no increase in Contract Price.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:
 - a. The Program/Project Manager may send paint samples from the paint provided for this Contract to the Independent Testing and Inspection Agency for testing to verify its adherence to the specified requirements.
 - 2. Inspections:
 - a. The Program/Project Manager will perform a final striping inspection within 3 working days after all pavement markings and markers have been applied and/or installed.
 - 1) Finished lines are to be smooth, opaque, aesthetically acceptable, and free from undue waviness.
- B. Non-Conforming Work
 - 1. If upon final inspection, the Program/Project Manager decides that more than one coat of paint is required, apply the additional coat(s) at no increase in Contract Price.

3.06 CLEANING

- A. Waste Management:
 - 1. Disposal of unused quantities of pavement marking paint is the responsibility of the Contractor, and must meet all applicable Federal regulations for waste disposal.
 - a. Unused paint must be identified on the container.



- b. Unused paint may be utilized on a future project provided the paint still conforms to all specifications contained herein.

3.07 PROTECTION

- A. If so ordered by the Program/Project Manager, remedy any condition where the safety of workmen or the traveling public might be endangered.

3.08 MAINTENANCE

- A. Perform daily maintenance and operation inspections of all application equipment to ensure that it is operable within the requirements of the Specifications.
 - 1. Inform the Program/Project Manager of any equipment breakdowns, intermittent malfunctions, or other conditions that may impact the proper application of the specified markings.
 - 2. Repair or replace any equipment judged to be unsuitable by the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.





SECTION 02766

RAISED PAVEMENT MARKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cleaning and preparing the pavement surface.
 - 2. Requirements for providing raised pavement markers of the type indicated in ADOT standard details and/or on the Contract Drawings for the locations shown.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 02223 – Removal of Pavement Markings and Markers.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADOT: Arizona Department of Transportation.
 - 2. RPM: Raised pavement marker.
 - 3. RRPM: Retro-reflective raised pavement marker.
- B. Definitions:
 - 1. Dagmar: A reflectorized raised pavement marker (RPM) having a circular base and a spherical or parabolic crown.
- C. Reference Standards:
 - 1. Arizona Department of Transportation (ADOT):
 - a. ADOT Arizona Supplement to the 2009 Manual on Uniform Traffic Control Devices.
 - b. ADOT Standard Drawings –Signing and Marking Standards.
 - 1) Drawing No. M-19, Sheet 1 of 9 – Raised Pavement Marker Plan Legend.
 - 2) Drawing No. M-19, Sheet 2 of 9 – Non-Reflective Raised Pavement Marker Details.
 - 3) Drawing No. M-19, Sheet 3 of 9 – Retro-Reflective Raised Pavement Marker Details.
 - 4) Drawing No. M-19, Sheet 4 of 9 –Pavement Marking Application and General Notes.
 - 5) Drawing No. M-19, Sheet 5 of 9 – Pavement Marking Details for Undivided Highways.



- 6) Drawing No. M-19, Sheet 6 of 9 – Series 40 Retro-Reflective Raised Pavement Markers (RPM) for Undivided Highways.
- 7) Drawing No. M-19, Sheet 7 of 9 – Series 80 Retro-Reflective Raised Pavement Markers (RPM) for Undivided Highways.
- 8) Drawing No. M-19, Sheet 8 of 9 – Typical Marking Details for Divided Highways.
- 9) Drawing No. M-19, Sheet 9 of 9 – Pavement Marking Cross-Section Details for Highways.
- c. ADOT Standard Specifications for Road and Bridge Construction.
 - 1) Section 706 – Raised Pavement Markers.
2. U. S. Government:
 - a. Department of Transportation (DOT):
 - 1) Federal Highway Administration (FHWA):
 - a) FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the Work of this Section with the appropriate State and municipal departments who own the Right-of-Way where the raised pavement marker installation is to occur.
- B. Sequencing:
 1. Include provisions for traffic control during pavement marker installation operations in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the workers and the public.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Samples:
 - 1) Raised pavement markers.
 - b. Certificates:
 - 1) Certificates of Compliance for raised pavement markers.
 - 2) Certificates of Compliance raised pavement marker adhesive.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Raised pavement marker manufacturer's installation instructions.



b. Manufacturer's Reports:

- 1) Material Safety Data Sheets (MSDS) for the bituminous adhesive.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Right-of Way Owner Approvals:

- a. Required approvals depend on who owns the right-of- way and where the painted pavement markings are to be applied, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - 1) Arizona Department of Transportation (ADOT).
 - 2) City of Phoenix Street Transportation Department.
 - 3) Phoenix Sky Harbor International Airport Design and Construction Services.
- b. If the owner of the Right-of-Way is other than the Phoenix Sky Harbor International Airport, the owner of the Right-of-Way will be provided on the Contract Drawings.

B. Certifications:

1. Submit Certificates of Compliance for raised pavement markers and adhesive to the Program/Project Manager for approval at least 10 days prior to use.

C. Site Samples:

1. Submit a minimum of one Sample per lot to the Program/Project Manager for approval for each type of marker provided.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Notify the Program/Project Manager of the proposed sources of the materials provided under this Section prior to their delivery in order to expedite inspection and/or testing of the materials.

B. Storage and Handling Requirements:

1. Store and handle raised pavement markers as recommended by the marker's manufacturer.
2. Store and handle raised pavement marker adhesive as recommended by the adhesive manufacturer.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not install raised pavement markers when the temperature of the pavement surface or the atmosphere is less than 40 degrees Fahrenheit,



when the relative humidity is 80 percent or higher, or when the pavement surface is not dry.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Reflective Pavement Markers:

1. Provide reflective pavement markers of the prismatic reflector type consisting of a molded shell filled with a mixture of an inert thermosetting compound and filler material, and complying with the requirements indicated in Drawing Number M-19, Sheets 1 through 3, of the ADOT Standard Drawings –Signing and Marking Standards.
 - a. Shell Material: Methyl methacrylate or suitably compounded acrylonitrile butadiene styrene (ABS).
 - b. Shell Surface: Smooth exterior containing one or two prismatic reflector faces of the color specified.
2. Reflector Color:
 - a. Provide clear, yellow, or red as designated for the marker type when illuminated by a vehicles headlight.
 - 1) Reflector color must be approved, and those not meeting the required color requirements may be rejected.
3. Reflector Surface:
 - a. Bond thin untempered glass or other abrasion resistant material to the prismatic reflector face to provide an extremely hard and durable, abrasive resistant reflector surface on permanent reflective pavement markers.
 - 1) Provide an area covered by glass or abrasion resistant surface not less than 3 square inches.
 - 2) Glass, or another abrasion resistant surface, is not required on the red faces of two-way (clear/red) permanent reflective markers.
4. Marker Base:
 - a. Provide a base free from glass glaze or from substances that may reduce its bond to the adhesive.
 - b. Base Flatness: No deviation of more than 0.05 inches from a flat surface.
5. Specific intensity:
 - a. Provide each reflecting surface for both temporary and permanent reflective markers with an original specific intensity not less than that shown in Table 02766-1.



Table 02766-1 Specific Intensity of Reflecting Surfaces			
Reflectance	Specific Intensity (Candelas/Foot-Candle)		
	Clear	Yellow	Red
0 Degrees Incidence	3.0	1.8	0.75
20 Degrees Incidence	1.2	0.72	0.30

6. Reflective pavement markers type designations are as follows:
 - a. Type C: Clear, red, two-way.
 - b. Type D: Yellow, two-way.
 - c. Type E: Clear, yellow, two-way.
 - d. Type G: Clear, one-way.
 - e. Type H: Yellow, one-way.
7. Manufacturers:
 - a. Ennis Paint, <http://www.ennispaint.com/products/product.asp?ID=7>.
 - b. 3M, Traffic Safety Systems Division, <http://solutions.3m.com/wps>.
 - c. Safeline Industries/Highway Ceramics, Inc.
 - d. Pac-Tec, Inc., <http://www.rayolite.com/braa.pdf>.

B. Reflectorized Dagmars:

1. Provide reflectorized dagmars with top surfaces in reasonably close conformity with the configuration shown for types J and JY on Drawing Number M-19, Sheet 3 of 9, of the ADOT Standard Drawings –Signing and Marking Standards, and the Contract Drawings.
 - a. Provide reflectorized dagmars with encapsulated lens reflectors conforming to standard manufacturing practices.
 - b. Provide convex markers with radius of curvature between 3.5 inches and 6.0 inches, except that the radius of curvature of the 1/2-inch nearest the edge may be less.
 - c. Round all edges and ensure that any change in curvature is gradual.
 - d. Provide smooth top and sides free of mold marks, pits, indentations, air bubbles, or other marks or discolorations.
2. Provide reflectorized dagmars consisting of a heat-fired, vitreous ceramic base and a heat-fired, opaque glazed surface that will produce the required properties.
 - a. Produce markers from any suitable combination of intimately mixed clays, shales, flints, feldspars, or other inorganic material that will meet the properties required by the Specifications.
 - b. Provide markers thoroughly and evenly matured and free from defects that will affect appearance or serviceability.
3. Provide dagmars and non-reflective pavement markers complying with the requirements of Table 02766-2.



Table 02766-2 Pavement Marker and Dagmar Requirements	
Property	Requirement
Glaze Thickness, minimum	0.005 inches
Moh Hardness, minimum	6
Directional Reflectance (White Only), minimum	
Glazed Surface	75
Body of Marker	70
Yellowness Index (White Only), maximum	
Glazed Surface	0.07
Body of Marker	0.12
Color (Yellow Only)	
Purity, Range	75 to 96 percent
Dominant Wave Length, μ , Range	579 to 585
Total Luminous Reflectance (Y value), minimum	0.41
Compressive Strength, minimum	1500 pounds
Water Absorption, maximum	2.0 percent
Autoclave	Glaze cannot spall, craze, or peel

4. Reflectorized dagmar type designations are as follows:
 - a. Type J: White.
 - b. Type JY: Yellow.
5. Manufacturers:
 - a. Ennis Paint, <http://www.ennispaint.com/products/product.asp?ID=7>.
 - b. 3M, Traffic Safety Systems Division, <http://solutions.3m.com/wps>.
 - c. Safeline Industries/Highway Ceramics, Inc.
 - d. Pac-Tec, Inc., <http://www.rayolite.com/braa.pdf>.

2.02 DESIGN CRITERIA:

- A. Provide raised pavement markers conforming to the dimensional and material requirements shown in the applicable ADOT Standard Drawings and specified in the ADOT Standard Specifications for Road and Bridge Construction.



- B. If the raised pavement markers are within Arizona Department of Transportation (ADOT) right-of-way, comply with the material and construction requirements of the applicable Sections in the ADOT Standard Specifications for Road and Bridge Construction and Arizona Standard Specifications, and with the applicable ADOT Standard Drawings.

2.03 ACCESSORIES

- A. Bituminous Adhesive:
 - 1. Provide approved bituminous adhesive compatible with the raised pavement markers they are fastening and capable of bonding the markers to the asphalt or concrete substrate.
 - 2. Submit Material Safety Data Sheets (MSDS) for the bituminous adhesive to the Program/Project Manager for information.
 - 3. Manufacturers:
 - a. Crafcro, Inc., <http://www.crafcro.com>.
 - b. Martin Asphalt Company, <http://www.martinasphalt.com>.
 - c. Ennispaint, Inc., www.ennispaint.com.
 - d. Approved equal.
- B. Adhesive thinners and solvents:
 - 1. Provide adhesive thinners and/or solvents that are not detrimental to the markers or the bond provided by the bituminous adhesive.

2.04 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Source Tests:
 - a. Test permanent and temporary reflective pavement markers as follows:
 - 1) Compressive Strength Test:
 - a) Test Method:
 - (1) Compressively load a permanent or temporary reflective pavement marker and measure the load until failure.
 - b) Acceptance Criteria:
 - (1) Both permanent and temporary reflective pavement markers tested must withstand a load of at least 2,000 pounds without failure.
 - 2) Abrasion Resistance Test:
 - a) Test Method:
 - (1) Temporary reflective pavement markers, or permanent reflective pavement markers used as temporary markers, do not need to be tested for abrasion resistance.
 - (2) Form a 1 0-inch diameter flat pad using No. 3 coarse steel wool.
 - (3) Place the steel wool pad on the reflector lens face.



(4) Apply a force of 50 pounds and rub the entire lens surface 100 times.

b) Acceptance Criteria:

(1) After the lens has been abraded, the specific intensity of each clear and yellow reflective surface may not be less than that required in Table 02766-1.

B. Non-Conforming Work:

1. Do not use raised pavement markers that do not pass the source tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Prior to installing raised pavement markers, lay out the pavement marker locations as indicated on the Contract Drawings and ADOT Standard Drawings –Signing and Marking Standards, on a line approved by the Program/Project Manager.
 - a. Do not locate raised pavement markers within 4 inches of a pavement joint.
 - b. Do not locate raised pavement markers on pavement surfaces that show visible evidence of pavement cracking, checking, spalling, or failure of underlying base material.

B. Evaluation and Assessment:

1. If existing conditions require a raised pavement marker's location to change, relocate the marker longitudinally to a location as directed by the Program/Project Manager.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.

B. Surface Preparation:

1. Remove dirt, existing painted lines, curing compound, grease, oil, moisture, loose or unsound layers, and any other material that could adversely affect the bond of the adhesive from that portion of the roadway on which the markers are to be placed.
2. Use a method of cleaning the pavement surfaces and removing detrimental material that is approved by the Program/Project Manager and includes sweeping and the using high-pressure air spray.
 - a. On Portland cement concrete pavement and old asphaltic concrete pavements, clean the pavement surfaces by sandblasting, followed by sweeping and/or air blowing.



- b. Newly placed asphalt concrete pavement does not need to be sandblasted unless, in the opinion of the Program/Project Manager, the surface is contaminated with materials that would adversely affect the bond of the adhesive.

3.03 INSTALLATION

- A. Install the raised pavement markers in accordance with the manufacturer's recommendations and the requirements of this Section.
 - 1. Submit the raised pavement marker manufacturer's installation instructions to the Program/Project Manager for information.
- B. Place adhesive uniformly on the cleaned pavement surface with no voids present and sufficient to completely cover the area that will come into contact with the markers with a slight excess amount after the markers have been placed.
- C. Install the markers on a line approved by the Program/Project Manager and in such a manner that the reflective face of the markers is perpendicular to a line parallel to the roadway centerline.
 - 1. Place the markers in position and apply pressure until firm contact is made with the pavement.
 - 2. Remove excessive adhesive on the pavement or on the exposed surface of the markers immediately.
 - a. To remove the excess adhesive, do not use thinners or solvents that may be detrimental to the markers or the bond provided by the adhesive.
- D. Interface with Other Work:
 - 1. Do not install pavement markers over longitudinal or transverse joints of the pavement surface.

3.04 PROTECTION

- A. Protect the markers against impact until the adhesive has set to the degree acceptable to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition





SECTION 02769

TACTILE WARNING SURFACE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for surface applied detectable/tactile warning surface tiles where indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. PVC: Polyvinyl-chloride.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - b. ASTM C 936 - Standard Specification for Solid Concrete Interlocking Paving Units.
 - c. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
 - 2. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)].
 - b. Department of Justice:



- 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
3. Institute for Sustainable Infrastructure (ISI):
 - a. a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Tactile warning surface pavers.
 - 2) Edge restraints.
 - 3) Filter cloth.
 - 4) Paver sealer.
 - b. Shop Drawings:
 - 1) Tactile warning surface pavers.
 - c. Samples:
 - 1) Tactile warning surface paver tile Samples.
 - 2) Samples of each type and kind of restrainer strip.
 - d. Certificates:
 - 1) Tactile Warning Surface Paver Tile Certificate of Compliance.
 - e. Qualification Statements:
 - 1) Tactile warning surface paver tile Testing and Inspection Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Tactile warning surface paver manufacturer's literature describing installation procedures.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Tactile warning surface paver tile manufacture's information regarding routine maintenance practices, including sealing and cleaning, for each type of paver tile and accessory provided.
 - b. Sustainable Design Closeout Documentation:



- 1) In accordance with ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Tactile Warning Surface Paver Tile Testing and Inspection Agency's Qualifications:
 - a. To perform the testing of the tactile warning surface paver tile provided under this Section, employ the services of one or more independent certified testing laboratories having the following qualifications:
 - 1) Each testing laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 699.
 - a) Each testing laboratory must have the experience and capability to satisfactorily perform the reviews, inspections, and testing required of them by this Contract, including but not limited to, inspecting, sampling, and testing proposed materials and systems as required by the Program/Project Manager for compliance with the Contract Documents.
 - b) The testing laboratory must be approved by the Program/Project Manager.
 - b. Dismissal and replacement of any of these independent certified testing laboratories by the Contractor requires written notice to and the approval from the Program/Project Manager.
 - c. Submit the qualifications and certifications of the proposed testing laboratories to the Program/Project Manager for approval.

B. Certifications:

1. Supplier/Manufacturer's Certificates of Compliance:
 - a. Tactile Warning Surface Paver Tile Certificate of Compliance:
 - 1) Employ a qualified accredited independent testing laboratory to conduct certification tests on a surface applied detectable/tactile warning surface tile system similar in every way to the system being provided under this Section.
 - 2) Submit a written Certificate of Compliance from the qualified accredited independent testing laboratory, certifying that the tactile warning surface paver tile materials being provided meet or exceed the requirements specified, to the Program/Project Manager for approval.

C. Sustainability Standards Certifications:



1. Recycled Content ENVISION Submittals:
 - a. For concrete containing recycled content, submit Product Data, including documentation indicating percentages by weight of post-consumer and pre-consumer recycled content, certifying that these products qualify the Project to claim ENVISION Credit RA 1.3 Use Recycled Materials: At Least 20% From Recycled Materials.
 - b. These credits are based on weight or volume.

D. Site Samples:

1. Tactile Warning Surface Paver Tile Samples:
 - a. Submit a minimum of 2 tile Samples of each type and color proposed for the Work of this Section to the Program/Project Manager for approval.
 - b. Submit 2 Samples of each type and kind of restrainer strip specified, each strip Sample 6 inches in length, to the Program/Project Manager for approval.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver materials in their original packages, containers, or bundles bearing the brand name and identification of the manufacturer or supplier.

B. Storage and Handling Requirements:

1. Tactile Warning Surface Paver Units:
 - a. Store and handle tactile warning surface units so breakage and other damage is avoided.
2. Tactile Warning Surface Paver Accessories:
 - a. Store metal accessories so corrosion is prevented.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURED TACTILE WARNING SURFACE PAVERS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain tactile warning surface pavers from single source from single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Provide pavers manufactured in accordance with the requirements specified in the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for aligned domes.
 - 2. Sustainability Requirements:
 - a. ENVISION Credits:
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials: At Least 20% From Recycled Materials.
- C. Performance:
 - 1. Compressive Strength:
 - a. Provide pavers having a minimum compressive strength of 8500 psi when tested in accordance with the requirements specified in ASTM C 67.
 - 2. Absorption:
 - a. Provide pavers having a boiling water absorption percentage of 5 percent when tested in accordance with the requirements specified in ASTM C 67.
 - 3. Freezing and Thawing:
 - a. Provide pavers receiving a "passing" grade when tested in accordance with the requirements specified in ASTM C 67.
- D. Design Criteria:
 - 1. Provide concrete pavers complying with the requirements specified in ASTM C 936.
 - 2. Consider local soils and drainage conditions, the type of expected traffic, and municipal requirements when designing the base material for the paver installation.
 - 3. Product Data:
 - a. Obtain Product Data for the tactile warning surface paver products and accessories including the manufacturer's literature describing the products, installation procedures, and routine maintenance.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings for the tactile warning surface pavers showing material to be used, fabrication details, composite structural system,



tile surface profile, fastener locations, and plans of tile placement including joints, installation materials, and procedures.

- b. Submit the Shop Drawings to the Program/Project Manager for approval.

E. Materials:

1. Tactile Warning Surface Pavers:

- a. Provide high density, hydraulically pressed concrete pavers having tactile warning surfaces, and made from Portland cement and both fine and coarse aggregate.
- b. Size:
 - 1) Provide tactile warning surface pavers sized as indicated in the Contract Drawings, or as indicated in approved Shop Drawings.
- c. Thickness:
 - 1) Provide tactile warning surface pavers having the thickness indicated in the Contract Drawings, or as indicated in approved Shop Drawings.
- d. Manufacturers:
 - 1) Hanover Architectural Products, <http://www.hanoverpavers.com>.
 - 2) Approved equal.

F. Fabrication:

1. Shop Fabrication:

- a. Provide pavers produced by subjecting a homogeneous concrete mix to a minimum pressure of 1,000 pounds per square inch over entire surface area to create the high density and strength of natural stone, and a specialized non-slip textured and non-directional surface finish, which exposes the aggregate giving the paver a granite-like appearance.

2. Fabrication Tolerances:

- a. Size Tolerance:
 - 1) Provide concrete tactile warning surface pavers manufactured to within plus or minus 1/8 inch of the size indicated in the manufacturer's Product Data.

2.02 ACCESSORIES

A. Edge Restraints:

1. Provide edge restraints fabricated from wood, steel, polyvinyl-chloride (PVC), or other systems specifically designed to restrain concrete pavers.

B. Filter Cloth:

1. Provide geotextile filter cloth as recommended by the paver manufacturer.

C. Paver Sealer:

1. Provide the paver manufacturer's recommended paver sealer.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the elements and surfaces to receive the tactile warning surface pavers for compliance with the installation tolerances and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the tactile warning surface pavers.
- B. Surface Preparation:
 - 1. Edge Restraint:
 - a. Provide adequate edge restraints.
 - 1) If providing a bituminous setting bed, edge restraints can be wood, steel, polyvinyl-chloride (PVC), or other systems specifically designed to restrain concrete pavers.
 - 2. Base:
 - a. Provide a properly prepared base.
 - 1) A bituminous setting bed over a 4-inch thick concrete base slab is the preferred method for pavers; however, an asphaltic concrete base slab is also acceptable.
 - 2) Alternate installation methods include a latex modified mortar setting bed over a concrete base slab.
 - b. If paver are being installed as an overlay system on existing concrete or asphalt pavement, provide filter cloth over the existing pavement prior to installing the pavers.

3.03 INSTALLATION

- A. Install and seal the tactile warning surface pavers in accordance with the manufacturer's installation instructions.
 - 1. Submit the manufacturer's written installation instructions to the Program/Project Manager for information.



3.04 CLEANING

- A. After installation, clean the detectable warning surface paver tile surfaces as recommended by the paver tile manufacturer.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 MAINTENANCE

- A. For each type of paver tile and accessory provided, submit the detectable warning surface paver tile manufacture's information regarding maintenance practices, including sealing and cleaning, to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.03.C, 1.04.C, 2.01.B	Add requirements for ENVISION Sustainability Rating System



SECTION 02786

TACK COAT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for tack coat for bituminous paved surfaces.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Definitions:
 - 1. Anionic: Asphalt globules that are electro-negatively charged.
 - 2. Cationic: Asphalt globules that are electro-positively charged.
- B. Reference Standards:
 - 1. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications for Public Works Construction.
 - 1) Section 713 – Emulsified Asphalts.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Certificates:
 - 1) Certificates of Compliance for tack coat.

1.04 QUALITY ASSURANCE

- A. Certifications:
 - 1. Certificates of Compliance:
 - a. At the time tack coat is delivered, submit 3 copies of a Certificate of Compliance from the Supplier certifying that the material complies with the material properties specified, and that includes the following information:
 - 1) Name of the refinery and Supplier.
 - 2) Quantity delivered.
 - 3) Delivery ticket number.
 - 4) Purchase order number.



- 5) Test results for the property tests specified in Table 02786-1 or Table 02786-2 as applicable for the type and grade.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Once emulsified asphalt has been loaded into vehicles for transportation to the Site, do not allow the material's temperature to exceed the maximum temperature for the type or grade indicated in Table 02786-3.
2. Do not allow the material's temperature to cool below 40 degrees Fahrenheit.
3. If emulsified asphalt is held overnight, prior to further application reheat the material while agitating it to avoid localized overheating.
 - a. When heating emulsified asphalt, do not allow steam or hot oils to be introduced directly into the material.
4. If emulsified asphalt separates, thoroughly mix it to insure homogeneity; however, if it has separated due to freezing, do not use the material.
5. Do not use emulsified asphalt after 30 days from the date it was delivered.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Tack coat:

1. Provide a mixture of 50 percent homogeneous emulsified asphalt, as specified in MAG Section 713, or Table 02786-1 and Table 02786-2; and 50 percent water.
2. The type, grade, or other designation will be indicated on the Contract Drawings or specified by the Program/Project Manager.

Table 02786-1 Designation and Properties for Anionic Emulsified Asphalt [Part 1]

Property	Type						
	Rapid Setting		Medium Setting			Slow Setting	
	Grade RS-1	Grade RS-2h	Grade MS-1	Grade MS-2	Grade MS-2h	Grade SS-1	Grade SS-1h
	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max
Emulsion Viscosity Test, Saybolt Furol at 77° F, second	20/100		20/100	100/ -	100/ -	20/100	20/100
Emulsion Viscosity Test, Saybolt Furol at 122° F, second		75/400					
Settlement, 24-hour day, percent	1	1	1	1	1	1	1

**Table 02786-1 Designation and Properties for Anionic Emulsified Asphalt [Part 1]**

Property	Type						
	Rapid Setting		Medium Setting			Slow Setting	
	Grade RS-1	Grade RS-2h	Grade MS-1	Grade MS-2	Grade MS-2h	Grade SS-1	Grade SS-1h
	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max
Demulsibility, 35ml 0.02 N CaCl ₂ , percent	60	60					
Coating ability and water resistance							
Dry and aggregate			Good	Good	Good		
After spraying			Fair	Fair	Fair		
Wet aggregate			Fair	Fair	Fair		
After spraying			Fair	Fair	Fair		
Sieve test, %	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cement mixing test, %						2.0	2.0
Residue by distillation, %	55	63	55	65	65	57	57
Test on residue form distillation test							
Penetration, 25° C 100g 5 seconds	100/200	40/90	100/200	100/200	40/90	100/200	40/90
Ductility, 25° 5cm/minute, cm	40/ -	40/	40/ -	40/	40/ -	40/	40/ -
Solubility in trichloroethylene, %	97.5/ -	97.5/	97.5/ -	97.5/	97.5/ -	97.5/	97.5/ -



Table 02786-2 Designations and Properties of Anionic/Cationic Emulsified Asphalt [Part 2]

Property	Type							
	Quick Setting		Rapid Setting		Medium Setting		Slow Setting	
	Grade QSH	Grade CQSH	Grade CRS-1	Grade CRS-2h	Grade CMS-2	Grade CMS-2h	Grade CSS-1	Grade CSS-1h
	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max
Emulsion Viscosity Test, Saybolt Furol at 77° F, second	20/100						20/100	20/100
Emulsion Viscosity Test, Saybolt Furol at 122° F, second			20/100	100/400	50/450	50/450		
Settlement, 24-hour day, percent			1	1	1	1	1	1
Demulsibility, 35ml 0.8% sodium dioctyl sulfosuccinate, percent			40	40				
Coating ability and water resistance								
Dry aggregate					Good	Good		
After spraying					Fair	Fair		
Wet aggregate					Fair	Fair		
After spraying					Fair	Fair		
Particle charge test ⁽¹⁾	Negative	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Sieve test, %	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cement mixing test, %							2.0	2.0
Distillation								
Oil distillate, by volume of emulsion, %			3	3	12	12		
Residue, %	57	57	60	65	65	65	57	57
Test on residue from distillation test								
Penetration, 25° C 100g 5 seconds	40/110	40/110	100/250	40/90	100/250	40/90	100/250	40/90
Ductility, 25° 5cm/minute, cm	40	40	40	40	40	40	40	40
Solubility in trichloroethylene, %	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Storage stability test, 1 day, %	1	1						

**Table 02786-2 Designations and Properties of Anionic/Cationic Emulsified Asphalt [Part 2]**

Property	Type							
	Quick Setting		Rapid Setting		Medium Setting		Slow Setting	
	Grade QSH	Grade CQSH	Grade CRS-1	Grade CRS-2h	Grade CMS-2	Grade CMS-2h	Grade CSS-1	Grade CSS-1h
	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max	Min/Max
1. If the Particle Charge Test result is inconclusive for CSS-1 and CSS-1h, material having a maximum pil value of 6.7 is acceptable.								

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Do not apply the tack coat until the Program/Project Manager has inspected the surface and determined that it is suitable for tack coating.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent property by preventing the emulsion from being sprayed on adjacent pavements, including that portion of the pavement being used for traffic, on structures, guard rails, guide posts, markers, trees, shrubs, and property of all kinds.

B. Surface Preparation:

1. Immediately before applying the tack coat, clean the area to be coated by removing loose material, dirt, and other objectionable material.
 - a. In urban areas, clean the surfaces with a self-propelled pickup sweeper.
 - b. In rural areas, clean the surfaces with power brooms.
 - c. If necessary, supplement the cleaning with hand brooming.

3.03 EQUIPMENT

A. Distributor Trucks:

1. Trucks:
 - a. Furnish pressure type distributor trucks having insulated tanks and designed to uniformly apply material in controlled amounts ranging from 0.05 to 2.0 gallons per square yard.
 - b. The transverse variation rate may not exceed 10 percent of the specified application rate.
 - c. Do not use gravity distributors.
2. Spray Bars and Extensions:



- a. Furnish fully circulating type spray bars, adjustable to permit varying the height above the surface to be treated.
3. Nozzles:
 - a. Space nozzles to not exceed 6 inches center to center.
4. Valves:
 - a. Furnish valves having the capability for one valve or all valves to be opened or closed quickly in one operation.
 - b. To control the flow of material from the nozzles, furnish positive acting valves designed to provide a uniform, unbroken spread of material on the surface.
5. Distributor Equipment:
 - a. Furnish devices and charts providing an accurate, rapid determination of the amount of material being applied, and capable of controlling the amount of material dispensed.
 - b. Furnish an auxiliary wheel type tachometer to register the speed in feet per minute.
 - c. Furnish pressure gauges and an accurate thermometer to determine the temperature of the material.
 - d. Furnish a hose and nozzle attachment for spotting skipped areas inaccessible to the distributor.

B. Hand Spraying Equipment:

1. Furnish a hose or bar with a gear pump or air tank for providing the pressure required to dispense material.

3.04 APPLICATION

- A. Apply tack coat using distributor trucks, taking care to provide uniform coverage.**
1. Apply the tack coat at a rate of 0.05 to 0.10 gallons per square yard.
 2. Apply the tack coat in advance of subsequent construction as ordered by the Program/Project Manager.
 - a. Do not apply more bituminous material in 1 day than will be covered by bituminous mixed materials during that same day.
 3. Maintain the distributor trucks to prevent material dripping from any part of the equipment.
 4. Unless otherwise specified or directed by the Program/Project Manager, apply tack coat at temperatures within the ranges indicated in Table 02786-3.

Table 02786-3 Application Temperatures		
Grade of Emulsified Asphalt	Minimum (°F.)	Maximum (°F.)
RS-1, MS-1, SS-1, SS-1h, CSS-1, CSS-1h	70	140



Table 02786-3 Application Temperatures		
Grade of Emulsified Asphalt	Minimum (°F.)	Maximum (°F.)
RS-2, MS-2, MS-2h, CRS-1, CRS-1h, CRS-2h, CMS-2, CMS-2h, QSH, CQSH	125	185

B. Special Techniques:

1. For resurfacing Work, corners, or tacking vertical edges, it is acceptable to use hand spraying equipment.

C. Interface with Other Work:

1. Ensure that the emulsified asphalt has broken before placing asphaltic concrete.

3.05 SITE QUALITY CONTROL

A. Non-Conforming Work

1. Remove equipment that performs unsatisfactorily from the Project.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.





SECTION 02789

ASPHALTIC-RUBBER SEAL COATS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for asphaltic seal and fog coats consisting of an application of a hot paving grade asphalt and ground tire rubber mixture on existing pavement surfaces immediately covered with a cover material.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 02786 - Tack Coat.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. COC: Cleveland Open Cup.
 - 2. SUS: Saybolt Universal Seconds.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. ASSHTO M 29 – Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
 - b. ASHTO T 89 - Standard Method of Test for Determining the Liquid Limit of Soils.
 - c. ASSHTO T 90 - Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
 - d. ASSHTO T 104 – Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - 2. ASTM International (ASTM):
 - a. ASTM C 117 – Standard Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - c. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - d. ASTM D 5 - Standard Test Method for Penetration of Bituminous Materials.
 - e. ASTM D 36 - Standard Test Method for Softening Point of Bitumin (Ring-and-Ball Apparatus).



- f. ASTM D 88 - Standard Test Method for Saybolt Viscosity.
- g. ASTM D 92 - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester.
- h. ASTM D 297 - Standard Test Methods for Rubber Products—Chemical Analysis.
- i. ASTM D 850 - Standard Test Method for Distillation of Industrial Aromatic Hydrocarbons and Related Materials.
- j. ASTM D 2007 - Standard Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method.
- k. ASTM D 2042 - Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene.
- l. ASTM D 2939 - Standard Test Methods for Emulsified Bitumens Used as Protective Coatings.
- m. ASTM D 2994 - Standard Test Methods for Rubberized Tar [*withdrawn*].
- n. ASTM G 154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
- 3. International Slurry Surfacing Association (ISSA):
 - a. ISSA TB 2007 – Design Technical Bulletins.
 - 1) ISSA TB 100 - Test Method for Wet Track Abrasion of Slurry Surfaces.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate closures of pavement areas for performance of the Work of this Section with the Program/Project Manager.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Samples:
 - 1) Material Samples.
 - b. Certificates:
 - 1) Test Report and Certification for Bituminous Materials.
 - c. Delegated Design Submittals:
 - 1) Asphaltic-rubber seal coat design mix.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Manufacturer's Instructions:
 - 1) Manufacturer's installation recommendations and instructions.

1.05 QUALITY ASSURANCE

- A. Certifications:
 - 1. Certificates of Compliance:
 - a. Prepare Certificates of Compliance from the Supplier certifying that the material delivered to the Site complies with the material properties specified, and that include the following information:
 - 1) Name of the asphaltic-rubber seal refinery and Supplier.
 - 2) Quantity delivered.
 - 3) Delivery ticket number.
 - 4) Purchase order number.
 - 5) Test results for the property tests specified in Table 02789-1, Table 02789-2, and Table 02789-3.
 - b. Have an authorized representative of the Supplier sign the test reports to certify that the product delivered conforms to the specified requirements.
- B. Site Samples:
 - 1. At least 7 days prior to application, submit material Samples to the Program/Project Manager for approval.
 - a. When requested by the Program/Project Manager, submit additional Samples at no increase in Contract Price.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. At the time asphaltic-rubber seal coat material is delivered, submit 3 copies of the Certificate of Compliance from the Supplier to the Program/Project Manager for approval.
 - 2. Until the certified test reports and Samples of the material have been checked and approved by the Program/Project Manager, that material will only be tentatively accepted by the Program/Project Manager.
 - a. Final acceptance depends upon the Program/Project Manager determining that the material represented by the tests and Samples fulfills the requirements specified.
- B. Storage and Handling Requirements:
 - 1. Store and handle emulsified asphalt in accordance with the requirements specified in Section 02786, Tack Coat.
- C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not apply the asphaltic-rubber seal material unless the ambient and surface temperatures are at least 60 degrees Fahrenheit and rising.
 - a. Do not apply the mixture during unsuitable weather or when there is an imminent threat of rain.

PART 2 PRODUCTS

2.01 ASPHALTIC-RUBBER AND FOG SEAL COAT SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.

2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Provide a clay-stabilized, mineral filled, modified asphalt emulsion designed to protect asphalt pavements.

C. Materials:

1. Modified Clay-Stabilized Mineral Filled Asphalt Emulsion:

- a. Provide clay-stabilized, mineral filled, asphalt emulsion modified with terminal blended, ground whole scrap tire asphalt cement.
- b. Asphalt Emulsion:
 - 1) Provide an asphalt emulsion having the properties specified in Table 02789-1.

Table 02789-1 Asphalt Emulsion Properties		
Property	Test Method	Requirement
Minimum residue by evaporation	ADTM D 2939	50 percent
Minimum weight at 25 degrees Celsius	ADTM D 2939	10 pounds per gallon
Wet track abrasion	ISSA TB 100	Less than 5 percent loss



Table 02789-1 Asphalt Emulsion Properties		
Property	Test Method	Requirement
Accelerated weathering test for 1000 hours	ADTM G 154	Pass
Aggregate content	Manufacturing controls	2 to 3 pounds per gallon
Material conformity	ADTM D 2939	Pass
Flash point	ADTM D 2939	Pass/None
Drying time	ADTM D 2939	Pass
Resistance to heat	ADTM D 2939	Pass
Resistance to water	ADTM D 2939	Pass
Flexibility	ADTM D 2939	Pass
Wet flow	ADTM D 2939	Pass
Resistance to volatilization	ADTM D 2939	Pass
Wet film continuity	ADTM D 2939	Pass
Resistance to impact	ADTM D 2939	Pass

c. Ground Vulcanized Rubber:

- 1) Provide vulcanized rubber scrap free from fabric, wire, and other contaminating material.
- 2) Provide vulcanized rubber scrap having natural rubber content of at least 25 percent by weight when analyzed in accordance with the requirements specified in ASTM D 297.
- 3) Grind the rubber so it is dry and free flowing after grinding, and has the gradation indicated in Table 02789-2 when tested in accordance with the method specified in ASTM C 136.
 - a) To prevent sticking or caking of the particles, mineral powder such as calcium carbonate may be added to the rubber, but may not be more than 4 percent by weight of the mixture.

Table 02789-2 Ground Vulcanized Rubber Gradation	
Sieve Size	Percent Passing by Weight
Number 8	100
Number 30	25 to 50
Number 50	5 to 45

**Table 02789-2 Ground Vulcanized Rubber Gradation**

Sieve Size	Percent Passing by Weight
Number 100	0 to 10

d. Rubber Modified Asphalt Cement:

- 1) Provide a rubber modified asphalt cement having the properties specified in Table 02789-3.

Table 02789-3 Rubber Modified Asphalt Cement Properties

Property	Test Method	Requirement	
		Min.	Max.
Percent of rubber in cement	Terminal certification	10	-
Penetration 77 degrees, 100g, 5 seconds, dmm	ASTM D 5	15	35
Softening point in degrees Fahrenheit.	ASTM D 36	130	160
Solubility percent	ASTM D 2042	98	-

e. Bentonite Clay and Ball Clay:

- 1) Provide bentonite clay and ball clay as required by the rubber modified asphalt cement manufacturer.

f. Manufacturers:

- 1) Sealmaster®, MasterSeal™ MTR (Modified Tire Rubberized Sealcoat), <http://www.sealmaster.net>.
- 2) Approved equal.

2. Extender Oil:

- a. Provide extender oil consisting of a resinous, high flash point, naphthenic/aromatic hydrocarbon having the properties specified in Table 02789-4.

Table 02789-4 Extender Oil Properties

Property	Test Method	Requirement
Viscosity, at 100 degrees Fahrenheit	ASTM D 88	2500 SUS, minimum
Flash point, Cleveland Open Cup, degrees Fahrenheit	ASTM D 92	390° F. minimum



Table 02789-4 Extender Oil Properties		
Property	Test Method	Requirement
Molecular analysis		
Asphaltines, percent by weight	ASTM D 2007	0.0 maximum
Aromatics, percent by weight	ASTM D 2007	55.0 minimum

3. Sand Blotter:

- a. Provide sand consisting of fine, granular, disintegrated or crushed rock that is free from organic material, mica, loam, clay, and other substances deleterious to its use as a sand blotter.
- b. Provide sand complying with the requirements specified in AASHTO M 29; except provide sand having the gradation in Table 02789-5 instead of the gradation in AASHTO M 2, having a sand equivalent not less than 50, and that is non-plastic when tested in accordance with the requirements specified in AASHTO T 89 and AASHTO T 90.

Table 02789-5 Sand Blotter Gradation	
Sieve Size	Percent Passing by Weight
3/8 inch	100
Number 4	90 to 100
Number 200	0 to 12

4. Stone Chips (Cover Material):

- a. Provide stone chips consisting of crushed rock, stone, or gravel having at least one rough, angular surface; and having the following properties:
 - 1) Weight Loss:
 - a) Provide stone chips having a weight loss less than 40 percent when tested in accordance with the method specified in ASTM C 131 for 500 revolutions.
 - 2) Sodium Sulfate Soundness:
 - a) Provide stone chips having a weight loss less than 12 percent when tested in accordance with the method specified in AASHTO T 104.
- b. Provide stone chips having the gradation indicated in Table 02789-6 when tested in accordance with the methods specified in ASTM C 117 and ASTM C 136.



- 1) A minimum of 75 percent by weight of the material retained on the Number 8 sieve must have at least one fractured face produced by crushing.

Table 02789-5 Stone Chips (Cover Material) Gradation	
Sieve Size	Percent Passing by Weight
3/4 inch	100
1/2 inch	97 to 100
3/8 inch	70 to 100
1/4 inch	0 to 10
Number 8	0 to 5
Number 200	0 to 2

- c. Provide stone chips
5. Tack Coat:
 - a. Provide tack coats complying with the requirements specified in Section 02786, Tack Coat.
6. Flush Coat:
 - a. Provide a flush coat consisting of grade SS-1h, grade CSS-1h, or grade CQSH emulsified asphalt complying with the requirements specified in Section 02786, Tack Coat, diluted in a proportion of 50 percent water to 50 percent emulsified asphalt.
7. Water:
 - a. Provide potable water compatible with the asphaltic-rubber seal and fog coat ingredients used.
- D. Mixes:
 1. Provide a properly proportioned mixture-including asphalt, ground tire rubber, bentonite clay, ball clay, extender oil, carbon black, water, and mineral aggregate mixed to a uniform consistency.
 - a. Submit the mix design to the Program/Project Manager for approval.
 2. Based on 100 gallons of the rubber modified asphalt cement, provide a mix compounded as follows:
 - a. Rubber Modified Asphalt Cement: 100 gallons.
 - b. Water: 20 to 25 gallons.
 - c. Sand: 100 to 300 pounds.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the surface to receive the asphaltic-rubber seal coat is dry.
 - 2. Locate cracks and grease, oil, and gasoline spots that must be remediated before application of the asphaltic-rubber seal coat.
- B. Evaluation and Assessment:
 - 1. Do not apply the asphaltic-rubber seal until an inspection of the surface has been made by the Program/Project Manager, and he has determined the surface is suitable.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from application of the asphaltic-rubber seal and fog coats.
 - 2. Take care to prevent spraying asphaltic-rubber seal on adjacent pavements, including portions of pavement being used by traffic, on structures, guard rails, guide posts, markers, trees, shrubs, and property of all kinds.
- B. Surface Preparation:
 - 1. Before applying the asphaltic-rubber seal and fog coats to new asphalt surfaces, allow the surfaces to cure for a minimum of 4 weeks under ideal weather conditions, which means having a temperature above 70 degrees Fahrenheit and low humidity.
 - 2. Repair existing pavement surfaces using suitable hot or cold asphalt mix.
 - a. Fill cracks with hot-applied or cold-applied crack fillers.
 - b. Treat grease, oil, and gasoline spots using compounds specially formulated for the purpose.
 - 3. Apply a tack coat as directed by the Program/Project Manager.
 - 4. Immediately before applying the asphaltic-rubber seal, clean the asphalt surface so it is free from loose material, dirt, dust, and other objectionable material.
 - a. Clean the surface with a self-propelled pick up sweeper or power brooms.
 - b. When necessary, supplement the cleaning using hand brooms.
 - c. Water flushing will not be permitted in areas where cracks are present in the pavement surface.
 - d. Water Fogging:
 - 1) In hot weather, the asphalt surface may be pre-wetted by fogging with water prior to applying the asphaltic-rubber seal coat.



- 2) Perform the fogging so the entire surface is damp with no apparent flowing water or puddles.

3.03 APPLICATION

A. Asphaltic-Rubber Seal:

1. Mix the asphaltic-rubber seal materials until the consistency of the mixture approaches that of a semi-fluid material and the reaction is complete.
 - a. At the time of application, the viscosity of the mixed asphaltic-rubber seal must be in the range of 500 centipoises and 4000 centipoises when tested in accordance with ASTM D 2994.
2. As soon as the mixed asphaltic-rubber seal reaches the proper consistency, begin to apply the material.
 - a. Using squeegees, brushes, or spray equipment, apply 2 coats of the mixed asphaltic-rubber seal to the pavement surface in accordance with the manufacturer's installation recommendations and instructions.
 - b. Apply between 0.13 gallon and 0.15 gallon per square yard per coat depending on the pavement's age and porosity, and the method of application.
 - c. Before applying the second coat, allow the first coat of asphaltic-rubber seal to dry for a minimum of 2 to 4 hours under ideal weather conditions, which means having a temperature above 70 degrees Fahrenheit and low humidity.
 - 1) Allow additional drying time in shaded areas due to reduced ambient and surface temperatures.
 - d. Apply the second coat in a cross direction to the first coat.
 - e. Submit the manufacturer's installation recommendations and instructions to the Program/Project Manager for information.

B. Cover Material:

1. Apply the cover material as soon as practical after the asphaltic-rubber seal is applied.
 - a. Preheat and pre-coat the cover material with rubber modified asphalt cement so the quantity of asphalt cement used is not less than 0.30 percent or more than 0.70 percent of the combined weight of the rubber modified asphalt cement and aggregate, and ensure the rubber modified asphalt cement is present on the aggregate.
2. Roll the cover material within 1 hour after it has been applied to insure maximum embedment of the aggregate.
3. Where areas adjacent to the cover material are to receive an asphaltic-rubber seal coat, sweep the edges of these joints clean of cover material prior to applying the asphaltic-rubber seal coat.
 - a. Place building paper over the ends of the previous application to make transverse joints.
 - b. Begin the adjoining application on the building paper.



- c. Once the application process as progressed beyond the building paper, remove and properly dispose of the building paper.
 - d. Avoid skips and overlaps at joints.
- C. Sand Blotter:
 - 1. Where there is an excess of asphaltic-rubber seal, apply a sand blotter.
 - 2. At signalized intersections after rolling and prior to opening a lane to traffic, apply 2 to 5 pounds of sand per square yard through the intersection and for a distance of 200 feet each way from the near curb returns.
 - 3. After the treated area has been opened to traffic, cover excess asphaltic-rubber seal that comes to the surface with additional sand.
- D. Flush Coat:
 - 1. After sweeping, but prior to striping, apply a flush coat consisting of 0.05 to 0.10 gallons per square yard to the asphaltic-rubber seal treatment.
 - a. Application of the flush coat may be delayed to facilitate curing, or to avoid placemen under unfavorable high temperature conditions.
 - b. Do not apply the flush coat to the area 200 feet on either side of and through signalized intersections.

3.04 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Do not allow traffic on the surface until the cover aggregate has set.
- B. Protect the treated surface using barricades until the asphaltic-rubber seal will not be picked up by traffic.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.





SECTION 02805

PET WATER FOUNTAIN

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for pet water fountain.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 02316 - Trenching and Backfilling.
 - 5. Section 04810 - Unit Masonry Assemblies.
 - 6. Section 09960 - High-Performance Coatings.
 - 7. Section 02810 - Irrigation System

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. PVC: Polyvinyl-chloride.
- B. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME A112.18.1/CSA B125.1 - Plumbing Supply Fittings.
 - b. ASME B1.20.7 - Hose Coupling Screw Threads, Inch.
 - 2. ASTM International (ASTM):
 - a. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
 - 3. United States Government:
 - a. United States Department of Agriculture (USDA):
 - 1) Animal and Plant Health Inspection Service:
 - a) 9 CFR 3.10 Watering.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of pet water fountain with the installation of the water lines provided by others, the supporting structures provided under Section 04810, Unit Masonry Assemblies.



B. Sequencing:

1. Prior to installing the pet water fountain, the adjacent surfaces where the pet water fountains are to be mounted and the water supply piping for the waterers must be completed.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pet water fountain
 - b. Shop Drawings:
 - 1) Pet water fountain
 - c. Samples:
 - 1) Draw down Samples of the paint for use on the piping.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Pet water fountain manufacturer's published installation instructions.

1.05 QUALITY ASSURANCE

A. Site Samples:

1. Submit draw down Samples of the paint for use on the piping to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver all materials in the manufacturer's original packaging.
2. Thoroughly inspect the materials upon receipt, and report damaged material to the delivering carrier.

B. Storage and Handling Requirements:

1. Store materials in dry, protected, well-vented area.

C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 PET WATER FOUNTAINPET WATER FOPUNTAIN ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Design Criteria:
 1. Provide ground-mounted pet fountain designed to furnish dogs with fresh clean drinking water.
 2. Provide pet water fountain that comply with United States Department of Agriculture (USDA) standards.
 3. Product Data:
 - a. Obtain the manufacturer's Product Data for the pet water fountain provided under this Section, including the pet water fountain manufacturer's published installation instructions.
 - b. Submit pet water fountain manufacturer's Product Data to the Program/Project Manager for approval.
 4. Shop Drawings:
 - a. Prepare Shop Drawings for the pet water fountain s, including layout drawings.
 - b. Submit the pet water fountain Shop Drawings to the Program/Project Manager for approval.
- C. Materials:
 1. Pet water fountain s:
 - a. Unit shall be constructed of 14 gage type 304 stainless steel polished to a satin finish with 18 gage pet fountain bowl. Bottom plate shall be 3/16" thick and include three mounting holes with two additional mounting holes for pet fountain. 1/2" expansion anchor bolts shall be furnished. All other exposed fasteners shall be vandal resistant



stainless-steel screws. Stainless steel access panel shall be vandal resistant.

- b. Pet fountain push button shall be self closing requiring less than 5 pounds of force to activate the internally mounted valve.
- c. Bubbler shall be stainless steel with an anti-rotation, a non-squirt feature and operate on a water pressure range of 20-105 psig.
- d. Inlet strainer shall be 100 mesh.

2.02 ACCESSORIES

A. Copper Pipe and Tubing:

- 1. Provide new seamless Type K copper pipes and tubes conforming with the requirements for Type K copper as specified in ASTM B 88.
 - a. Fabricate the pipe or tubing from copper free from cuprous oxide when examined at a microscopic magnification of 75 diameters.
 - b. Anneal Type K tubing furnished in coils after coiling.
- 2. Pipe Fittings:
 - a. For copper pipe and tubing, provide copper or bronze fittings as required.

B. Connector Hoses:

- 1. Provide a 12 inch long braided connector hoses.
- 2. Manufacturers:
 - a. Model M-PM34 Stainless Steel Series Round Pedestal Push Button Pet Fountain Receptor <https://www.murdockmfg.com/home> Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

- 1. Examine the elements and surfaces to receive the pet water fountain for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Evaluation and Assessment:

- 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:



1. Protect adjacent areas from damage resulting from installation of the pet water fountain.
- B. Surface Preparation:
 1. If required, perform excavating, trenching, and backfilling operations for water piping in accordance with the requirements specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 1. If required, perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Pet water fountain:
 1. Install the pet water fountain in accordance with the manufactures installation instructions at the locations indicated in the Contract Drawings.
 - a. Submit the pet water fountain manufacturer's published installation instructions to the Program/Project Manager for information.
- B. Interface with Other Work:
 1. Piping System Connections:
 - a. Connect the pet water fountain connector hose, and piping to the piping provided by others as indicated in the Contract Documents.
 - b. For piping and specialties adjacent to the equipment, install the piping and specialties to allow access for service and maintenance.
 2. Encase pipe that passes through concrete in Schedule 40 polyvinyl-chloride (PVC) pipe sleeves, or wrap the pipe with tape.

3.04 ADJUSTING

- A. Adjust the pet water fountains so the proper water level is maintained in the reservoir.

3.05 CLEANING

- A. Continuously keep the Site neat and orderly.
- B. Upon completion of the pet water fountain, remove all temporary structures, rubbish, waste material, tools, and equipment resulting from or used in the installation of the system from the Owner's property.
- C. Waste Management:



1. Properly dispose of the waste material generated by the installation of the pet water fountain.
2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	11/17/2017	J2		Edited
2	3/27/2018	J2		Replaced dog water with Pet Water Fountains



SECTION 02810

IRRIGATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for landscape irrigation systems as shown or reasonably implied on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01410 - Regulatory Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 02316 - Trenching and Backfilling.
 - 6.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. AWG: American Wire Gauge.
 - 3. IPT: Inside pipe thread.
 - 4. NPT: National pipe thread tapered thread.
 - 5. PVC: Polyvinyl chloride.
 - 6. SWP: Steam Working Pressure.
 - 7. UV: Ultraviolet.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
 - b. ASTM D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - c. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, schedules 40, 80, and 120.
 - d. ASTM D 2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - e. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - f. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 2. American Water Works Association (AWWA):



- a. AWWA C509 - AWWA Standard for Resilient-Seated Gate Valves for Water Supply Service.
 - b. AWWA C515 - AWWA Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
3. City of Phoenix (COP):
 - a. Phoenix Supplemental Standard Details for Public Works - Construction:
4. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit.
 - 3) Dust Control Logs.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
 - 2) Regulation III – Control of Air Contaminants:
 - a) Rule 300 – Visible Emissions,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/300-0803.pdf.
 - b) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
 - c) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.
5. NSF International (NSF):
 - a. NSF/ANSI 14 - Plastics Piping System Components and Related Materials.
6. State of Arizona:
 - a. Arizona Revised Statutes (ARS):
 - 1) Chapter 2, Article 6.3, Underground Utilities, ARS 40-360.21 through 32.
 - 2) Chapter 2, Article 6.4, Overhead Powerline Safety Law, ARS 40-360.41, 45.
7. Maricopa Association of Governments (MAG):
 - a. Uniform Standard Specifications and Details for Public Works Construction January 2017
8. Institute for Sustainable Infrastructure:
Envision sustainable infrastructure rating system.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the installation of irrigation materials so there will be no interference with utilities or other construction, and no future difficulty planting trees, shrubs, and ground covers.
 - a. Exercise extreme care when excavating and working near existing utilities.
 - b. Take responsibility for damages to utilities that are caused by Contractor operations or neglect.
3. Coordinate the installation of pipe sleeves with the paving and other contractors so that all required sleeves are installed prior to any paving operations and to so no conflicts occur with other utilities or structures.
4. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona 811 at 1-800-782-5348 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.
5. Do not interfere with persons, firms, corporations, or utilities, removing, changing, replacing, or employing protective measures at their property or structures.
 - a. Allow these persons, firms, corporations, or utilities to take such measures as they may consider necessary or advisable under the circumstances.
 - b. Measures employed or not employed by these entities do not relieve the Contractor of his responsibilities.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Plastic pipe and fittings including sleeve piping.
 - 2) Copper pipe and fittings.
 - 3) Polyvinyl chloride (PVC) solvent cement.
 - 4) Polyvinyl chloride (PVC) cleaner and primer.
 - 5) Flexible tubing.
 - 6) Emitters.
 - 7) Gate valves
 - 8) Ball Valves.
 - 9) Automatic remote control valves.
 - 10) Valve access boxes.
 - 11) Automatic controllers.
 - 12) Flow meter.
 - 13) Pressure regulator assemblies.
 - 14) Strainers.
 - 15) Drip system flush plugs.
 - 16) Backflow preventers
 - 17) Backflow cages
 - 18) Control wiring.
 - 19) Gravel.
 - 20) Teflon tape.
 - 21) Warning tape
 - 22) Geotextile Fabric.
 - 23) Irrigation System Material List
 - 24) Grounding Equipment.
- b. Delegated Design Submittals:
 - 1) Completed controller charts.
- c. Special Procedure Submittals:
 - 1) Written evidence that the As-Built Drawings, accessories, charts, and equipment required have been provided or submitted prior to the Final Coverage Inspection of the irrigation system.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Irrigation system manufacturers' written installation recommendations and instructions.
 - 2) Valve manufacturers' installation recommendations, instructions, and wire charts.
 - b. Site Quality Control Submittals:
 - 1) Main Line Pressure Tests Report.
 - 2) Lateral Line Pressure Tests Report.
 - 3) Pressure Tests of Lines Under Paved Areas Report.
 - 4) Backflow Prevention Test Report



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Irrigation System Maintenance Contract.
 - b. Operation and Maintenance Data:
 - 1) Operations and Maintenance Manuals for the irrigation system.
 - c. Warranty Documentation:
 - 1) Irrigation System Warranty.
 - d. Record Documentation:
 - 1) Weekly As-Built Drawings of the landscape irrigation system.
 - 2) Final As-Built Drawings of the landscape irrigation system.
 - e. Sustainable Design Closeout Documentation:
 - 1) Envision compliance documentation

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Prior to Project Closeout, furnish spare irrigation parts matching the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Where applicable and shown on the Contract Drawings, furnish 20 spare single emitters of each size and type of single emitter.
 - b) Where applicable and shown on the Contract Drawings, furnish 10 spare multi-emitters of each size and type of multi-emitter.
 - c) Two drip filter and regulators.
 - d) Two lids for each size valve box installed.
 - e) One gate valve operating tee handle for 2" square nut.
 - f) Two drip flush end valves.
 - g) Furnish 2 spare automatic control valves of each size and type.
 - 2) Store the spare parts on the Site where directed by the Program/Project Manager.
 - b. Tools:
 - 1) Prior to Project Closeout, furnish irrigation tools as follows:
 - a) Furnish 2 operating keys for Controller.
 - 2) Store the tools on the Site where directed by the Program/Project Manager.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:



1. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
2. Dust Control Permit:
 - a. Comply with the requirements of the Maricopa County Dust Control Permit and air pollution control requirements, particularly Maricopa County Air Pollution Control Regulation Rules 310 and 310.01.
 - 1) Rule 310 requires maintaining daily logs recording the actual implementation of control measures identified in the Dust Control Permit.
 - b. Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.

B. Sustainability Standards Certifications:

1. Envision compliance documentation

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Follow the proper procedures for loading, unloading, and transporting the landscape irrigation system materials:

B. Storage and Handling Requirements:

1. Follow proper procedures for staking, storing, and handling the landscape irrigation system materials:
 - a. Avoid rough handling which could affect the useful life of the landscape irrigation equipment.
 - b. Polyvinyl Chloride (PVC) Pipe:
 - 1) Transport polyvinyl chloride (PVC) pipe in a vehicle that allows the length of pipe to lie flat so it is not subjected to undue bending or concentrated external loads at any point.
 - 2) Load, unload, and store the pipe as recommended by the pipe manufacturer.
 - 3) Furnish beds for storing the pipe that are the full length of the pipe stored.
 - 4) Protect polyvinyl chloride (PVC) pipe and related fittings from direct sunlight.
2. Keep the landscape irrigation system equipment in its original packaging until its installation.

C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not lay pipe when the temperature is 40 degrees Fahrenheit or below.

1.08 WARRANTY

A. Manufacturer Warranty:

1. Furnish the irrigation system manufacturer's standard Irrigation System Warranty against defective material and workmanship covering the 1-year period occurring after the Date of Substantial Completion.
 - a. Submit the irrigation system manufacturer's standard Irrigation System Warranty to the Program/Project Manager.

PART 2 PRODUCTS

2.01 IRRIGATION SYSTEM COMPONENTS

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.

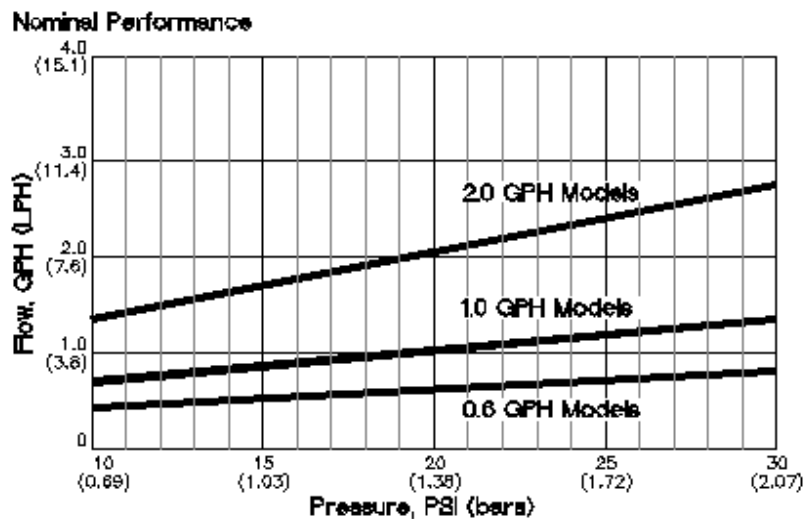
2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed may be provided.
 - 1) No substitutions for the articles, equipment, materials or processes specified by name in the Contract Documents will be allowed without prior written approval by the Program/Project Manager.
 - a) Equipment or material furnished or installed without the prior approval of the Program/Project Manager may be rejected, and the Contractor will be required to remove the rejected materials from the Site at no increase in the Contract Price.
 - b) The decision rendered by the Program/Project Manager when determining the quality and suitability of the materials and equipment to be provided is final.
 - b. Source Limitations:
 - 1) Unless otherwise approved by the Program/Project Manager, obtain similar materials from a single source and single manufacturer.

B. Description:



1. Regulatory Requirements:
 - a. Comply with the requirements of the State of Arizona regarding excavation and trenching.
 - b. Comply with the requirements of the Maricopa County air pollution control regulations.
 - c. Comply with the requirements of the AZPDES Construction General Permit (AZG2008-001) described in Section 01410, Regulatory Requirements.
 2. Institute for Sustainable Infrastructure:
 - a. Envision compliance requirements.
- C. Performance:
1. Emitters:
 - a. Provide emitters capable of performing within the following parameters:
 - 1) System Pressure Range: 15 psi to 35 psi.
 - 2) Flow Variation: 1.06 at 120 degrees Fahrenheit, and 1.07 at 150 degrees Fahrenheit.
 - 3) Manufacturing Variability: 0.05.
 - 4) Capacity:
 - a) Single Outlet Emitter:
 - (1) Provide single outlet emitters capable of performing as specified and shown for the 1 gallon per hour (gph) model in the following chart:



- a) 1.00 gallon per hour (gph) at 20 psi.
 - b) 1.14 gallons per hour (gph) at 24 psi.
 - c) 1.34 gallons per hour (gph) at 30 psi.
- b) Multi-Outlet Emitters, Type 1:



- (1) Provide multi-outlet emitters capable of performing the same as single-outlet emitters from each of 6 possible outlets.
 2. Pressure Regulator Assembly:
 - a. Provide pressure regulator assemblies capable of operating within the following parameters:
 - 1) Flow range: 0.5 to 18 gallons per hour.
 - 2) Inlet pressure: up to 110 psi.
 - 3) Outlet pressure: 30 psi.
- D. Design Criteria:
 1. The Contract Drawings are diagrammatic, and only indicate the general arrangement and routing of irrigation controls, equipment, piping, and fittings.
 - a. In the absence of details on the Contract Drawings, or Specifications pertaining to specific items required to complete the Work, perform the Work in accordance with the best standard of practice after obtaining the prior approval of the Program/Project Manager.
 - b. Where piping is shown under paved areas but running parallel and adjacent to non-paved areas, the intent of the Contract Drawings is to have the piping installed in the non-paved areas.
 - c. Provide the fittings and valves as required in accordance with the details on the Contract Drawings.
 - d. Do not provide excess piping or fittings which may increase pressure loss or potential blockage in the installed system.
 - e. Do not provide pipe in curving trenches that will cause excessive bending and stress on the pipe and fittings.
 - f. In the event of a conflict between the Contract Documents and the Phoenix Supplemental Standard Details for Public Works – Construction, the City's Standard Details take precedence.
 - g. Stations:
 - 1) Provide the number of stations as indicated in the Contract Documents.
 2. Control Valves:
 - a. Provide remote control valves capable of being activated manually from the satellite controller.
 3. Product Data:
 - a. Prepare Product Data for the articles, equipment, materials, or processes proposed to be provided under this Section.
 - b. Prior to performing any work, prepare a complete Irrigation System Material List, including the manufacturer, model number, size, and a description of each material to be used.
 - c. Submit the Product Data to the Program/Project Manager for approval.
 4. Record Documentation:



- a. Maintain a complete, up to date set of As-Built Drawings at the Site for reference.
 - 1) Prepare accurate and to scale As-built Drawings showing the entire completed landscape irrigation system as actually installed.
 - a) Prepare the as-built drawings of the landscape irrigation system electronically on AutoCAD file bases provided by the Program/Project Manager.
 - b) Prepare revisions in accordance with the Phoenix Sky Harbor International Airport standards.
 - (1) Use symbols for valves, emitters, piping, and similar items the same as originally shown by the Program/Project Manager.
 - c) Date and clearly label each final drawing as "AS-BUILT DRAWING".
 - d) Modify the legends as appropriate to designate any "As-built" changes.
 - 2) Correct the As-Built Drawings daily to show all changes in the location of irrigation emitters, controllers, backflow preventers, valves, drains, meters, points of connection, pull boxes and wire splice boxes, pipe and wire routing, sensors, and other changes that may have been made from the original Contract Documents as provided.
 - 3) Provide dimensions from 2 permanent points of reference, such as building corners, sidewalk intersections, or road intersections, to the location of the following items:
 - a) Connections to existing water lines.
 - b) Connections to existing electrical power.
 - c) Gate valves.
 - d) Routing of irrigation lines.
 - (1) Provide dimensions for points a maximum 100 feet apart along the routing.
 - e) Irrigation control valves.
 - f) Routing of control wiring.
 - g) Other related equipment as directed by the Program/Project Manager.
- b. Submit the As-Built Drawings to the Program/Project Manager weekly for review.

E. Materials:

1. Pipe:

a. Plastic Pipe:

- 1) For mainline and lateral pipe, either of the following types of rigid polyvinyl chloride (PVC) plastic pipe may be indicated to be provided on the irrigation plans and details in the Contract Drawings:



- a) For mainline pipe use schedule 40 PVC complying with the requirements specified in ASTM D 1785.
 - b) For lateral and sub-mainline piping use 40 PVC complying with the requirements specified in ASTM D 1785.
 - c) For sleeve piping use schedule 40 pipe complying with the requirements specified in ASTM D 1785.
 - b. Copper Pipe:
 - 1) Provide Type K, Standard weight copper pipe complying with the requirements for hard tempered copper tubing specified in ASTM B 88.
 - 2) Provide new, seamless copper pipe designed for underground water service, plumbing purposes, and similar applications.
 - c. Provide pipe continuously and permanently marked with the following information:
 - 1) Manufacturer's name or trademark.
 - 2) Size.
 - 3) Schedule.
 - 4) Type of pipe.
 - 5) Working pressure at 73 degrees Fahrenheit.
 - 6) NSF certification.
- 2. Pipe Fittings:
 - a. Plastic Fittings:
 - 1) For pipe having nominal pipe sizes of 2-1/2 inches and smaller, provide Schedule 40 solvent weld type fittings.
 - a) For mainlines fittings and all other fittings before the remote control valve, provide Schedule 80, Type 1, polyvinyl chloride (PVC) solvent weld slip connector fittings complying with the requirements specified in ASTM D 2466 and ASTM D 1784.
 - b) For lateral line fittings and all other fittings after the remote control valve, provide ultraviolet (UV) radiation resistant Schedule 40, Type 1, polyvinyl chloride (PVC) solvent weld slip connector fittings complying with the requirements specified in ASTM D 2466 and ASTM D 1784 for polyvinyl chloride (PVC) pipe.
 - b. Copper Fittings:
 - 1) Provide wrought copper, bronze, or brass solder end type fittings rated for a working water pressure class of 150 pounds.
- 3. Solvent Cements, Primers, and Lubricants:
 - a. Provide only solvent cements, primers, or lubricants recommended or supplied by the pipe manufacturer.
 - b. Polyvinyl Chloride (PVC) Solvent Cement:
 - 1) Provide polyvinyl chloride (PVC) solvent cement complying with the requirements specified in ASTM D 2564, and of the proper type for the conditions of use.
 - 2) Manufacturers:



- a) Industrial Polychemical Service, Weld-On 711, <http://www.ips-plastics.com>.
 - b) Approved equal.
 - c. Polyvinyl Chloride (PVC) Cleaner and Primer:
 - 1) Provide polyvinyl chloride (PVC) cleaner and primer of the proper type approved by the pipe manufacturer for the conditions of use.
 - 2) Manufacturers:
 - a) Industrial Polychemical Service, Weld-On P-70, <http://www.ips-plastics.com>.
 - b) Approved equal.
 - 4. Flexible Tubing:
 - a. Provide flexible distribution tubing (spaghetti tubing) manufactured from a black vinyl blend; and having an inside diameter of 0.160 inch, an outside diameter of 0.220 inch, and a minimum wall thickness of 0.030 inch.
- F. Manufactured Units:
- 1. Emitters:
 - a. Provide pressure compensating single and multi-outlet assemblies.
 - 1) Provide emitters having the number of manufacturer-supplied outlets required to be opened.
 - b. Emitter Assembly:
 - 2) Provide emitter assemblies consisting of an emitter unit, a 1/2-inch diameter flexible polyvinyl chloride (PVC) riser, and necessary fittings.
 - b. Case:
 - 1) Provide a durable black acetyl plastic case resistant to heat and temperature variations, smog, ozone, ultraviolet radiation, liquid fertilizer, and weed spray.
 - c. Diaphragm:
 - 1) Provide a self-flushing, 150 minimum filtration mesh diaphragm that is completely enclosed to protect it against harmful environmental factors.
 - 2. Gate Valves:
 - a. Gate valves shall be resilient seat, epoxy coated ductile iron with 2" square operating nuts, 250 psig and meet the requirements of ANSI/AWWA C515. American Flow Control 2500 series or approved equal.
 - 3. Ball Valves:
 - a. Ball valves 2-inch and smaller shall be of the brand, size and type indicated on the irrigation plans.
 - b. Ball valves shall have a one-piece body constructed of 600-lb WOG Bronze material conforming to ASTM B-584 alloy 844. Ball valve shall have a vented ball with a blowout proof system. Ball valves shall have a working pressure of not less than 150 P.S.I. and shall conform to



- AWWA standards. Ball valves shall include a stainless-steel handle. Type: Wilkins 850 or approved equal.
- c. Ball valves for use with remote control valves shall be Spears True Union or approved equal. The valves shall be manufactured of schedule 80 PVC and feature Teflon seats capable of two-way blocking. The valve shall have threaded end connections. Valves shall be sized to match the remote control valve.
4. Automatic Remote Control Valves:
- a. Provide slow-acting hydraulic diaphragm, globe screw pattern control valves sized as indicated on the Contract Drawings.
 - 1) Provide electric control valves that are compatible with the automatic controllers.
 - b. Actuation:
 - 1) To prevent damage from surge pressures, provide slow opening and closing electric solenoid actuation facilitated by a potential shunt resistor.
 - a) Provide solenoids having an opening and closing speed not less than 5 seconds.
 - b) Provide solenoids designed to operate on a 24-Volt, 60-Hertz power supply delivering 2 Watts of power.
 - c. Waterproofing:
 - 1) Ensure positive waterproofing by providing valves completely encapsulated in epoxy with a stainless-steel shunt band.
 - d. Flow Adjustment:
 - 1) Provide electric control valves having a manual flow adjustment.
 - e. Manufacturers:
 - 1) Provide the manufacturer and-model listed in the details on the Contract Drawings.
 - 2) Approved equal.
5. Air/Vacuum Release Valves:
- a. Air/vacuum release valves shall be gravity type constructed of cast iron. Air/vacuum release valve shall have an O-ring sealing device that positively seals at 3 P.S.I. and releases air once the water pressure inside the tubing drops below one P.S.I.
 - b. Ball valve shall be bronze with stainless steel handle. Size shall be 1".
 - c. The mainline tee shall be schedule 80 for sizes 2 ½" and smaller, ductile iron 3" and larger.
 - d. Valve boxes shall be Carson 1324-15 with Drop –N-Lock T-Style cover or equal. Include geo-textile fabric and 6" gravel sump.
 - e. Place air/vacuum release valves at the high point on the irrigation mainline.
 - f. Manufacturers:
 - 1) Provide the manufacturer and-model listed in the details on the Contract Drawings.
 - 2) Approved equal.



6. Valve Access Boxes:
 - a. Provide standard round or rectangular valve access boxes complying with the requirements specified in ASTM D 628, ASTM D 648, and ASTM D 790, and fabricated from plastic or as called for in the Contract Drawings.
 - 1) Provide valve boxes complete with bolt locking cover or lid, and locking cover keys for the locking covers.
 - b. Sizes:
 - 1) For gate valves and flush cap plugs, provide valve access boxes approximately 9 to 10 inches in diameter, and 12 inches deep. Type: Carson 910-12 or approved equal.
 - 2) For ball valves, master valves & flow meters, provide valve access boxes approximately 12 inches wide by 18 inches long, and 12 inches deep. Type: Carson 1220 or approved equal.
 - 3) For drip valve assemblies where the valve, filter & pressure regulator are in the same location, provide valve access boxes approximately 13 inches wide by 24 inches long, and 12 inches deep. Type: Carson 1324 or approved equal.
 - 4) For drip valve assemblies where the valve and the filter/ regulator are located in separate locations, provide valve access boxes for both the valve & filter/ regulator in approximately 12 inches wide by 20 inches long, and 12 inches deep. Type: Carson 1220 or approved equal.
 - 5) For drip emitters, provide emitter access boxes approximately 6 inches in diameter and 9 inches deep. Type: Carson 708 or approved equal.
 - c. Valve Access Box Extensions:
 - 1) Wherever required to bring the valve boxes level with the finish grade or to comply with details shown on the Contract Drawings, provide valve access box extensions of the proper length and size.
 - 2) Provide valve box extensions compatible with the valve boxes and as necessary to ensure the valve box rests on a continuous soil base.
 - 3) Provide valve box extensions fabricated from the same material and manufactured by the same manufacturer as the valve box.
 - d. Identification:
 - 1) Imprint the valve box lids with the words "IRRIGATION CONTROL VALVE" and the valve number.
7. Automatic Controllers:



- a. Irrigation controllers shall be RainMaster DX3 Laguna models which shall be compatible with the Sky Harbor irrigation central control system.
- b. Controllers shall be stainless steel pedestal mounted on a poured in place concrete base per plan details.
- c. Controllers shall be conventional wire models furnished with the number of stations as shown on the project plans.
- d. The controller shall use Ethernet communication provided by the electrical contractor.
- e. The controller shall include a PMR KIT radio receiver for remote controls. Provide one PROMAX complete remote control kit.
- f. The contractor shall have RainMaster upgrade the central control system software to work with the new DX3 Laguna operating system. This is a no cost operation provided by RainMaster. The contractor shall provide coordination between RainMaster and Sky Harbor Irrigation.
- g. Controller Charts:
 - 1) For each automatic controller, provide a controller chart showing the area controlled by the automatic controller.
 - a) Provide controller charts consisting of a drawing of the actual system reduced to the maximum size that will fit on the controller enclosure's door.
 - (1) In the event the controller sequence drawing is illegible when the drawing is reduced, enlarge the labels on the controller sequence drawing to a size that will be legible when the drawing is reduced to fit the door.
 - (2) Use a different color to indicate the coverage area for each station.
 - 2) Do not prepare the controller charts before the As-built Drawings required elsewhere in this Section are submitted to the Program/Project Manager and approved.
 - 3) Prior to the final coverage observation of the irrigation system, submit the completed controller charts to the Program/Project Manager for approval.
 - a) When the controller charts are completed and approved, provide a print of the chart on bond paper hermetically sealed between two pieces of plastic at least 10 mils thick.
8. Flow Meters:
 - a. Provide flow meters compatible with the automatic irrigation controller selected for the Contract.
9. Pressure Regulator Assemblies:
 - a. Provide pressure regulator assemblies fabricated from polyvinyl chloride (PVC), and having 3/4-inch minimum female NPT inlet and outlet connections.
10. Strainers:



- a. Provide “Y” (WYE) type strainers fabricated from bronze or brass; and having 1-inch female inside pipe thread (IPT) connections.
 - b. Provide strainers having a 100 mesh strainer fabricated from stainless steel or another material as indicated in the details on the Contract Drawings.
11. Drip System Flush Plugs:
- a. Provide drip system flush plugs as detailed on the Contract Drawings.
12. Backflow Preventers:
- a. Provide brass reduced pressure type backflow preventers as indicated on the Contract Drawings, that automatically reduce water pressure in the zone between the check valves to a pressure differential of 3 psi, and that are designed for maintenance and service without removal from the line.
 - 1) Check Valves:
 - a) For each backflow preventer, provide 2 separate spring-loaded “Y” type check valves.
 - 2) Pressure Relief Valves:
 - a) For each backflow preventer, provide 1 differential type pressure relief valve with 2 diaphragms that are separated by spaces.
 - 3) Shut-Off Valves:
 - a) For each backflow preventer, provide 2 ball valves.
 - 4) Test Cocks:
 - a) For each backflow preventer, provide test cocks for field-testing.
 - 5) Enclosure:
 - a) For each backflow preventer, provide an enclosure with a locking device over the backflow preventer assembly in accordance with the detail on the Contract Drawings.
 - b) Finish:
 - (1) Paint the enclosure with the color approved by the Program/Project Manager to match the City’s requirements, or as described in the detail on the Contract Drawings.

2.02 ACCESSORIES

- A. Control Wiring:
- 1. Provide control wiring complying with the requirements and sized as required or shown on the Contract Drawings, but in no case less than AWG 14.
 - 2. Direct Burial Wire:
 - a. For direct burial wire, provide 600-Volt AWG-UF copper wire.
 - 3. Pilot Wires:
 - a. Provide a different color pilot wire for each automatic controller.
 - 4. Common Wires:



- a. Provide white AWG 12 wire having a different color stripe for each automatic controller.
- 5. Wire Splices:
 - a. Make all splices using wire connectors with same manufacturer's sealant, or an approved equal.
- B. Gravel:
 - 1. Provide pea gravel complying with the requirements specified in MAG Section 310, Placement and Construction of Aggregate Base Course
- C. Teflon Tape:
 - 1. Provide Teflon tape manufactured as a thread sealing compound.
- D. Warning Tape:
 - 1. Provide solid detectable foil core warning tape encased in a protective plastic jacket that is resistant to alkalis, acids, and other destructive elements commonly found in soil.
 - a. Provide a foil/plastic lamination having sufficient strength so the layers cannot be separated by hand.
 - b. Provide warning tape having a 0.35-mil thick foil core, and a total composite thickness of at least 4.3 mils.
 - c. Insure that the foil core is visible to ensure continuity.
 - 2. Tensile Strength:
 - a. Provide warning tape having the minimum tensile strengths for a 3-inch wide strip of 63 pounds in the machine direction and 68 pounds in the traverse direction.
 - 3. Warning Message:
 - a. Provide warning tape having a continuous warning message reading "CAUTION IRRIGATION LINE BELOW" imprinted on the tape's surface and repeated every 16 to 36 inches.
 - 4. Tape Color:
 - a. Provide warning tape having the color code appropriate for the type of line that the tape is protecting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Carefully check all grades to ensure that the Work on the irrigation system can proceed safely.
- B. Evaluation and Assessment:
 - 1. Do not use any pipe or fitting that has been damaged or dented.
 - a. Discard any section of pipe that has been dented or damaged; and, if installed, replace the dented or damaged pipe with new piping.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the landscape irrigation system.
- B. Surface Preparation:
 - 1. Stakeout of Irrigation System:
 - a. Prior to starting to install the landscape irrigation system, flag all planting areas, locating each plant species by different flag colors.
 - b. Lay out the entire system using powdered lime or stakes to indicate the locations of the various system components and the location of each run of pipe.
 - 1) At this time, make preliminary adjustments to conform to the actual site conditions.
 - c. Arrange for the Program/Project Manager to review the stakeout of the entire system prior to performing actual production Work.
 - 1) Obtain the Program/Project Manager's approval of the flagging and the stakeout prior to starting to install the landscape irrigation system.
- C. Demolition/Removal:
 - 1. Trenching under Existing Paving:
 - a. If any cutting or breaking of existing paving is necessary, prior to performing the work obtain permission to cut or break the paving from the Program/Project Manager.
 - 1) If the Program/Project Manager approves the demolition, cut and remove the pavement; and after the landscape irrigation system work under the paving is completed, replace the paving in kind to a condition equal to or greater than the condition existing before the removal of the paving at no increase in Contract Price.

3.03 INSTALLATION

- A. Carefully install all irrigation system pipes, fittings, valves, and similar items in trenches.
 - 1. Install irrigation system piping, fittings, and the various assemblies in accordance with the details shown on the Contract Drawings, and in accordance with the irrigation system manufacturers' installation recommendations and instructions.
 - 2. Submit the irrigation system manufacturers' written installation recommendations and instructions to the Program/Project manager for information.
- B. Excavation:



1. Size trenches and other excavations large enough to accommodate the irrigation system components, conduit, and other required facilities.
 - a. Follow the layout for trenching excavation indicated on the Contract Drawings and as noted.
 - b. Dig trenches straight, and support pipe continuously on the bottom of the trench.
 - c. Provide additional space in trenches to assure proper installation and access for inspection.
2. Provide trenches sufficiently deep to furnish the minimum earth cover from finish grade in accordance with the details shown on the Contract Drawings.
3. Soil Conditions:
 - a. Rocky Soil:
 - 1) If the trenching must extend through rocky soil, bed the irrigation piping in 2 inches of sand or other approved backfill material, and extend the sand or other approved material a minimum of 2 inches over the top of pipe.
 - b. Other Unsuitable Soil Conditions:
 - 1) If the bottom of a pipe trench excavation is found to consist of rock, caliche, or another unsuitable material, notify the Program/Project Manager.
 - 2) Remove this material at least 3 inches below the specified trench depth.
 - 3) Refill the trench with sand or similar material approved by the Program/Project Manager, and thoroughly tamp and compact the sand or similar material into place.
4. Excavation Adjacent to Existing Trees:
 - a. If it is necessary to excavate adjacent to existing trees, avoid injuring to the trees and tree roots.
 - b. In areas where roots having diameters of 2 inches or larger occur, excavate by hand.
 - 1) Tunnel under roots having diameters of 2 inches or larger, except where the roots lie directly in the path of the pipe or conduit.
 - 2) Heavily wrap the roots that lie directly in the path of the pipe or conduit with burlap to prevent scarring or excessive drying.
 - c. In areas where roots having diameters smaller than 2 inches are encountered, hand trim the roots by making clean cuts through root.
 - d. Where possible close trenches adjacent to trees within 24 hours; but when this is not possible, keep the side of the trench adjacent to the tree shaded with moistened burlap canvas.

C. Sleeves:

1. Sleeves:

- a. Before paving work begins, provide sleeves under sidewalks, driveways, roadways, curbs, and elsewhere as shown on the Contract Drawings and as required to install the irrigation system.



- 1) Unless otherwise specified, provide sleeves for piping under paving.
- 2) For control wire under paving or structures, provide pipe sleeves separate from the water piping sleeves.
- 3) Install sleeves required under new paving prior to constructing the pavement.
- 4) Install sleeves that are required below existing paving by jacking, boring, or hydraulic driving.
- 5) Replace and re-compact fill around sleeves.
- b. Provide sleeves consisting of Schedule 40 polyvinyl chloride (PVC) pipe sized to be at least twice the diameter of the wire bundle or pipe(s) being sleeved, or larger if so indicated on the Contract Drawings.
- c. Immediately following installation of a sleeve, plug both ends of the sleeve.
- d. Where sleeve ends are concealed, provide visible and identifiable markers on the surface at both ends of the sleeve.
 - 1) Provide a number 4 steel reinforcement bar marker having the 6-inch length at one end painted red.
 - 2) Cut the steel reinforcement bars so that if the bar is set or pounded vertically into the ground and the bottom of the bar is at the depth of the bottom of the sleeve and a horizontal distance of approximately 6 inches away from the sleeve, the top of the bar will be flush with the finish grade.
 - 3) Mark the final location of the steel reinforcement bar marker by providing a red whisker marker set into the finish grade.
 - a) If alternate marking methods are proposed, they must be approved by the Program/Project Manager prior to their installation.

D. Piping:

1. Before installing the pipe, remove rubbish, large rocks, and water from the trenches.
 - a. Do not lay pipe in trenches with standing water, or when the trench or weather conditions are unsuitable for the Work.
 - b. Pump out or otherwise remove any water that may be encountered or may accumulate in the trenches or excavation as necessary to keep the bottom of the trench or excavation free and clear of water during the progress of the Work.
2. Thoroughly clean the pipe and fittings to remove dirt, dust, and moisture before installation.
3. Use the installation methods recommended by the pipe and fitting manufacturers.
 - a. For piping to be provided under existing walks, install the piping by jacking, boring, or hydraulic driving.



- b. For piping to be provided under concrete paving where no conflicts with other piping or utilities exist, hydraulic driving is permitted provided an 18 inch minimum depth is maintained.
 - c. Submit the installation methods recommended by the pipe and fitting manufacturers to the Program/Project Manager for information.
 4. For the below-grade mainline pipe, provide plastic pipe.
 - a. Install copper pipe from the water meter through a backflow preventer device to the below-grade plastic mainline pipe.
 - b. Assemble polyvinyl chloride (PVC) pipe and fittings so they are jointed at the true parallel position of the fitting.
 - c. For mainline pipe with a nominal diameter 3 inches or less, or where a pipe connection occurs in a sleeve, install solvent weld pipe.
 - 1) Comply with the pipe manufacturer's recommended procedures for making solvent weld fittings.
 - 2) Use primer on all solvent weld joints.
 5. Lay pipe to an even grade.
 - a. Rest the full length of each section of the pipe solidly upon the pipe bed, with recesses excavated to accommodate bells, joints, and couplings.
 6. Piping Connections:
 - a. Connecting Different Materials:
 - 1) Whenever connecting different materials using threaded connections, provide metal female connections.
 - 2) For polyvinyl chloride (PVC) to metal piping connections, install the metal piping first.
 - b. Threaded Connectors:
 - 1) Where threaded polyvinyl chloride (PVC) connections are required, use threaded polyvinyl chloride (PVC) male adapters into which the pipe may be welded.
 - 2) For polyvinyl chloride (PVC)-to-polyvinyl chloride (PVC) threaded joints, for polyvinyl chloride (PVC) to metal threaded joints, and for metal to metal threaded joints, provide Teflon tape thread sealing compound or an approved equal.
 - 3) Do not use thread sealing compound on threaded connections between a sprinkler and a nipple, a bubbler and a nipple, or an emitter and a riser.
 7. Warning Tape:
 - a. Apply detectable tape to all pressurized main lines and at the ends of lateral runs.
 8. For piping to be installed under new paving, prior to performing the paving work set the piping in place, and cap and pressure test the piping.

E. Valves:

1. Valve Access Boxes:
 - a. Unless otherwise indicated, install the electric remote control valves, zone shut-off valves, gate valves, quick coupler valves, and isolation



valves in suitable valve access boxes having the proper size to facilitate easy access for manually operating or maintaining the valve housed.

- 1) Provide a sump of pea gravel at least 6 inches deep, or as otherwise detailed on the Contract Drawings, below each valve body in the valve access box.
- b. Provide a control valve box for each electric remote control valve.
2. Pressure Regulator Assemblies:
 - a. Provide complete pressure regulator assemblies, including a valve box, pressure regulator, and other appurtenances at the location and in accordance with the details on the Contract Drawings.
3. Backflow Preventers:
 - a. Install backflow preventers on poured in place concrete slab per plan details.
 - b. Install backflow enclosure per plan details and secure to concrete base. Enclosures shall include a lock guard. Enclosure color shall be Woodland Tan.
4. Gate Valves:
 - a. Provide gate valves in accordance with the details on the Contract Drawings.
5. Ball Valves:
 - a. Provide ball valves in accordance with the details on the Contract Drawings.
6. Flow Meter Valve Assemblies:
 - a. Provide a flow meter valve assembly where shown on the Contract Drawings.
- F. Emitter Assemblies:
 1. Provide emitter assemblies consisting of an emitter unit with a strainer, lengths of flexible polyvinyl chloride (PVC) supply piping suitable for the pressure application required, and appropriate molded adapters for connecting the emitter assembly to supply laterals.
 2. Unless otherwise indicated, at each shrub and cacti provide single-outlet type emitters connected to the rigid polyvinyl chloride (PVC) emitter lateral as detailed on the Contract Drawings.
 3. At each tree, provide the quantity and type of multi-outlet type emitters having spaghetti tubing as indicated in the Emitter Schedule and Multi-Port Emitter Detail on the Contract Drawings.
 4. Whenever possible, provide each emitter assembly with its own outlet.
- G. Drip System:
 1. Provide drip system flush plugs on every dead end run to allow flushing all emitter pipes or tubing downstream of the last emitter.
 2. Install each drip system flush plug in a valve access box.
- H. Electric Control Wiring:



1. Connect the automatic controller to the electric control using direct burial wire. The electrical contractor shall provide the 120V protected circuit and conductors to the new irrigation controller.
2. Provide the control wiring in the same trench, and along the same route, as the pressurized mainline piping.
 - a. Before installing the wire, partially backfill the pipe trench to provide bedding for the wire adjacent to the pipe.
 - b. If it is necessary to run wire in a trench separate from the pipe trench, provide a minimum of 12 inches of cover for the wire, or the depth indicated on the Contract Drawings.
3. For control wire under paving or structures, provide Schedule 40 polyvinyl chloride (PVC) sleeves separate from water piping sleeves.
4. Laying the Wires in the Trench:
 - a. Lay the control wires loosely in the trench without stressing or stretching the conductors in accordance with the detail shown on the Contract Drawings.
 - b. For each wire run, provide a spare wire left open.
 - c. When more than 1 wire is placed in a trench, tape the wiring together at 10-foot intervals.
 - d. Lay warning tape 6 inches above the wire bundles in trenches.
5. Control Valve Wire Splices:
 - a. Field splices between the automatic controller and electrical control valves are not allowed without the prior approval of the Program/Project Manager.
 - b. Provide spliced wire having one continuous color; do not splice wires of different colors together.
 - c. Use no more than 1 wire splice per connector.
6. Splices of Wire Other Than Control Valve Wire:
 - a. Except at valve box locations, keep wire splices to a minimum and not more frequently than 2500 feet.
 - b. If required, provide wire splices only at common splice points, and place the splice in a wire splice box as shown in the detail on the Contract Drawings.
 - 1) Provide splice connectors and sealant to make the wire splice boxes waterproof.
7. Wire Expansion and Slack Provisions:
 - a. For control wiring, provide 12-inch expansion loops at every ninety-degree change of direction and at 100-foot intervals along the wire.
 - b. Expansion Joints (Curls):
 - 1) Provide expansion joints, or curls, in the wire at 200-foot intervals by making 5 or 6 turns of the wire around a piece of ½-inch pipe.
 - 2) Within 3 feet of each wire connection, provide an expansion curl.
 - 3) For each splice connection at electric controls, provide an expansion curl sufficiently long so the valve bonnet may be brought to the surface for repairs without disconnecting the control wires.



- c. Control Valve Splices:
 - 1) At control valve splices, provide a 36-inch wire expansion coil to facilitate raising the splices out of the splice box for observation or repair.
 - d. Locate wire connections at remote control valves and at wire splices in a valve box, and provide 24 inches of slack so the valve bonnet or splice may be brought to the surface for repair without disconnecting the wires.
- 8. Electrical Wire Connections:
 - a. Provide absolutely waterproof joints so there is no chance of water leakage or corrosion buildup on the joint.
 - b. Install common wires for the automatic controller and electric remote control valves in accordance with the valve manufacturer's recommendations, instructions, and wire chart.
 - 1) Submit the valve manufacturer's installation recommendations, instructions, and wire chart to the Program/Project Manager for information.
- 9. Wiring of Existing Controllers:
 - a. Several existing controllers are to be utilized for operation of the new irrigation system. The contractor shall protect in place all existing 120V power supply wiring and grounding for the controllers. The contractor shall run new 24V control, common and spare wiring from the existing controllers to the new valves shown on the plans. The new 24V wiring shall be orange control wire, yellow common wire and green spare wire colors to distinguish the new wiring from the existing wiring that may remain in the ground. The contractor shall remove all existing 24V wiring from previous irrigation systems which will not remain in service as can be reasonably pulled from the ground by mechanical methods.
- I. Flushing:
 - 1. After all landscape irrigation system piping, risers, valves, thrust blocks, and similar items have been installed and partially backfilled, but prior to installation of the heads, open the control valves and use a full head of water to flush out the system.
 - 2. Flush the system for 3 minutes through the furthestmost head from the valve.
- J. Backfill and Compaction:
 - 1. Backfilling:
 - a. Do not backfill piping until it has been inspected, hydrostatically tested, and accepted by the Program/Project Manager in writing.
 - b. After the irrigation system is operating, and all required tests and inspections have been made, backfill the excavations and trenches with clean soil free of debris and rocks in accordance with the requirements specified in Section 02316, Trenching and Backfilling.



- 1) Initially, place fine granular material backfill on all lines to a depth of 3 inches.
 - a) Do not place foreign matter larger than ½ inch in the initial backfill.
 - b) For flexible distribution tubing (spaghetti tubing) provide gravel bedding.
- 2) Backfill the trenches with suitable material excavated from the trench or in accordance with the details shown on the Contract Drawings.
- 3) Backfill trenches in 6-inch lifts with the excavated materials consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones.
- c. Backfilling Trenches under New Paving:
 - 1) If the trenches will be located under areas where new paving will be constructed, backfill the trench ensuring that a layer of sand or approved material is placed from 6 inches below the buried pipe to 3 inches above the pipe.
 - 2) Compact the backfill for these trenches in layers using manual or mechanical tamping devices that produce a firm, unyielding condition; and so the compaction of the backfill equals the compaction of the existing adjacent undisturbed soil or compaction required by an approved Geotechnical Engineer registered in the State of Arizona and by the Program/Project Manager.
- d. Backfill trenches flush with the adjoining grade.
 - 1) After backfilling the trench, use water to settle and level the trench to the grade of the adjacent ground.
2. Compaction:
 - a. Mechanically compact the backfill in landscaped areas to a dry density equal to the compaction of adjacent undisturbed soil in planting areas.
 - b. Compact the backfill to conform to adjacent grades without dips, settlement areas, humps, or other surface irregularities.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when the irrigation system is being installed, the Testing and Inspection Agency must perform routine and other testing and inspection of materials.
 - a. Notify the Program/Project Manager sufficiently in advance of irrigation system construction activities so appropriate Testing and Inspection Agency personnel can be scheduled with sufficient time to inspect and test the Work as follows:
 - 1) Pressurized main line installation and testing: 48 hours advance notice.
 - 2) Flushing: 48 hours advance notice.



- 3) Hydrostatic Testing: 48 hours advance notice.
 - 4) Automatic controller installation: 48 hours advance notice.
 - 5) Control wire installation: 48 hours advance notice.
 - 6) Lateral line and sprinkler installation: 48 hours advance notice.
 - 7) Emitter lateral and extension line placement: 48 hours advance notice.
 - 8) Emitter operation: 48 hours advance notice.
 - 9) Final coverage observation: 1 week advance notice.
 - 10) Test operation of all controllers from the maintenance central control facility.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Pressure Test:
- a. After the flushing specified herein is completed, cap the risers and hydrostatically pressure test the irrigation system.
 - 1) Perform the hydrostatic pressure tests with the Program/Project Manager present to observe the testing.
 - 2) Test the irrigation lines in place, before backfilling, and only under dry conditions.
 - 3) To prove piping that is installed under areas to be paved is watertight, test the piping prior to paving the area.
 - b. Main Line Testing:
 - 1) Prior to installing the electric control valves, hydrostatically test the main line upstream from the control valve locations.
 - c. Lateral Line Testing:
 - 1) Hydrostatically test lateral lines downstream from the control valves at the available system pressure.
 - d. Test Procedure:
 - 1) At least 4 hours before the testing the pressure, fill the line with water and thoroughly bleed the air out of the line.
 - 2) Center load the pipe sections, and expose all couplings.
 - a) Test the polyvinyl chloride (PVC) lateral line pipes at the existing line pressure with the couplings exposed and all outlets capped.
 - 3) Test all pressure lines under a hydrostatic pressure of 120 psi.
 - a) During the test period, maintain a minimum pressure of 100 psi at the highest point of the section being tested.
 - 4) Record the pressure in the irrigation lines for not less than 2 hours.



- 5) Submit the following certified Pressure Test reports demonstrating compliance with the requirements to the Program/Project Manager for information:
 - a) Main Line Pressure Tests Report for the hydrostatic testing of the main lines upstream from the control valves.
 - b) Lateral Line Pressure Tests Report for the hydrostatic testing of the lateral lines downstream from the control valves.
 - c) Pressure Tests of Lines Under Paved Areas Report for the hydrostatic testing of the piping under paved areas.
 - e. Acceptance Criteria:
 - 1) Main Lines:
 - a) The maximum permissible pressure drop is 2 psi after the temperature has stabilized.
 - 2) Lateral Lines:
 - a) The maximum permissible leakage is 0 gallon per hour per 1,000 feet of pipe.
 - 3) Lines having no evident leakage or loss of pressure as specified pass the Pressure Test.
 3. Inspections:
 - a. Periodic Site inspections will be performed by the Testing and Inspection Agency after the weekly As-Built Drawings for the items have been submitted.
- B. Non-Conforming Work
1. Rework any items found to be unacceptable by the Program/Project Manager during the Final Coverage Inspection to his complete satisfaction and at no increase in Contract Price.

3.05 ADJUSTING

- A. Settlement:
1. If settlement occurs, and subsequent adjustments in piping, valves, sprinkler heads, lawn or planting, or other construction are necessary, make the required adjustments at no increase in Contract Price.

3.06 CLEANING

- A. Continuously keep the Site neat and orderly.
- B. Keep the interior of pipes free from dirt and debris; and when pipe laying is not in progress, cap the open ends of the pipe using an approved means.
- C. Upon completion of the landscape irrigation system, remove all temporary structures, rubbish, waste material, tools, and equipment resulting from or used in the installation of the system from the Owner's property.
- A. Waste Management:



1. Properly dispose of the waste material generated by the installation of the irrigation system.
2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Final Coverage Inspection:

- a. Before requesting the Final Coverage Inspection of the irrigation system, submit written evidence to the Program/Project Manager that the As-Built Drawings, accessories, charts, and equipment required have been provided or submitted.
- b. Prior to final acceptance, arrange with the Program/Project Manager to have the Final Coverage Inspection performed by the following entities together:
 - 1) Program/Project Manager.
 - 2) Landscape Architect.
 - 3) City Representative.
 - 4) Contractor.
 - 5) Landscape Subcontractor.
- c. During the Final Coverage Inspection, operate each system in its entirety for the Program/Project Manager and others present to observe.

B. Record Documentation:

1. Prior to start of the warranty period, electronically submit the AutoCAD files and pdf files of the Final As-Built Drawings of the landscape irrigation system to the Program/Project Manager.
 - a. Delivery of the electronic file does not relieve the Contractor of responsibility for furnishing required information that may have been omitted.

3.08 PROTECTION

- #### A. Protect the landscape irrigation system Work and materials from damage during construction and storage.

3.09 MAINTENANCE

A. Operation and Maintenance Manuals:

1. Submit Operations and Maintenance Manuals for the irrigation system to the Program/Project Manager in accordance with the requirements specified in Section 01780, Closeout Submittals.

B. Maintenance Service:



1. Furnish an executed Irrigation System Maintenance Contract to the Owner for keeping the irrigation system in perfect operating condition during the warranty period at no increase in the Contract Price.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	11/172017		All	J2 Edits
2	5/10/2018		All	J2 Edits
3	7/09/2018		All	J2 Edits



SECTION 02821

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for chain link fence and gate components.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating (electric) current.
 - 2. EEPROM: Electrically erasable programmable random-access memory.
 - 3. VA: Voltamperes.
 - 4. VAC: Volts of alternating (electric) current.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 - b. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - c. ASTM A 641/A 641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - d. ASTM A 824 - Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.
 - e. ASTM F 567 - Standard Practice For Installation of Chain-Link Fence.
 - f. ASTM F 626 - Standard Specification for Fence Fittings.
 - g. ASTM F 900 - Standard Specification for Industrial and Commercial Swing Gates.
 - h. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot Dipped Zinc-coated (Galvanized) Welded, For Fence Structures.
 - i. ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concretes for Use in Construction and Criteria for Laboratory Evaluation.
 - j. ASTM D 2582 - Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.
 - 2. Chain Link Fence Manufacturers Institute (CLFMI):
 - a. CLFMI Step-By-Step Installation Guide.
 - 3. National Electrical Manufacturers Association (NEMA):



- a. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
- 4. U. S. Government:
 - a. Federal Aviation Administration (FAA):
 - 1) Aviation Administration Advisory Circulars (FAA AC):
 - a) FAA AC 150/5370-10C – Standards for Specifying Construction of Airports.
 - 2) United States General Services Administration (GSA):
 - a) Federal Specifications:
 - (1) Federal Specification RR-F-191/3E - Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification).

1.03 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Chain link fence framing members.
 - 2) Chain link fence framing accessories.
 - 3) Chain link fence fabric and wire.
 - b. Shop Drawings:
 - 1) Proposed chain link fence layout.
 - c. Certificates:
 - 1) Certified mill certificates.
 - d. Qualification Statements:
 - 1) Chain link fence fabricator qualifications.
 - 2) Chain link fence erector qualifications.

B. Informational Submittals:

- 1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Chain link fence manufacturer's installation information.

1.04 QUALITY ASSURANCE

A. Qualifications:

- 1. Fabricator Qualifications:
 - a. Employ a fabricator that is a continuing member of the Chain Link Fence Manufacturer Institute (CLFMI).
 - b. Submit the qualifications of the Fabricator to the Program/Project manager for approval.



2. Erector Qualifications:
 - a. Employ an erector that has at least one person in a supervisory capacity, who is skilled and experienced in erecting chain link fence, readily understands the proposed layout, and is completely familiar with current erection practices of the Chain Link Fence Manufacturers Institute (CLFMI).
 - 1) Have this person present during the chain link fence installation.
 - b. Submit the qualifications of the Erector to the Program/Project manager for approval.

B. Certifications:

1. Submit certified mill certificates indicating material conformity to the specified yield strengths to the Program/Project Manager for approval.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Identify each shipment of fence fabric as to the size of the mesh, the size of the wire, the height and length of the fabric in each roll, ASTM designation ASTM A 392, and the name or mark of the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers offering chain link fence and gate products which can comply with the requirements of this Section include, but are not limited to, the following:
1. Merchant Metals, Inc., www.merchantmetals.com.
 2. Master Halco, www.fenceonline.com.
 3. Approved equal.

2.02 DESIGN CRITERIA:

A. Chain Link Fences:

1. For airside applications, provide chain link fences complying with the requirements specified for Item F-162 in FAA AC 150/5370-10C where those requirements are more stringent than specified herein.

B. Configuration:

1. Install chain link fence and gates at the locations indicated on the Contract Drawings in accordance with the requirements of ASTM F 567.
 - a. Submit Shop Drawings of the proposed layout, and include the manufacturer's published details as modified to suit design and field conditions.



2. Provide chain link type fence with a top rail, bottom rail, and single extension arms carrying 3 strands of barbed wire unless otherwise indicated on the Contract Drawings.
3. Fabric Height: 8 feet unless otherwise indicated on the Contract Drawings.
4. Overall Height (Including barbed wire extensions): 9 feet unless otherwise indicated on the Contract Drawings.

C. Product Compatibility:

1. Provide all chain link fence components from one manufacturer.
 - a. Submit the manufacturer's Product Data for the products specified including descriptive literature, specifications, and installation information.

2.03 FENCE COMPONENTS

A. Framing Members:

1. Provide steel pipe complying with the requirements for Class 1 (steel pipe), Grade A (Standard Weight (schedule 40) pipe complying with the requirements specified for Regular Grade pipe in ASTM F 1083) as specified in Federal Specification RR-F-191/3E, and having a minimum yield strength of 30,000 psi and the following additional features:
 - a. Intermediate (Line) Posts:
 - 1) Provide fabricated tubular members.
 - 2) Nominal Size: 2 inches.
 - 3) Weight: 3.65 pounds per foot.
 - b. End, Pull, and Corner Posts:
 - 1) Provide tubular members.
 - 2) Nominal Size: 2-1/2 inches.
 - 3) Weight: 5.79 pounds per foot.
 - c. Gate Posts:
 - 1) Provide steel pipe or tubular members.
 - 2) Nominal Size:
 - a) For gate leaf widths up to 6 feet: 2-1/2 inches in diameter.
 - b) For gate leaf widths up to 13 feet: 3-1/2 inches in diameter.
 - c) For gate leaf widths up to 18 feet: 6 inches in diameter.
 - d) For gate leaf widths up to 23 feet: 8 inches in diameter.
 - 3) Weight:
 - a) For gate leaf widths up to 6 feet: 5.79 pounds per foot.
 - b) For gate leaf widths up to 13 feet: 9.11 pounds per foot.
 - c) For gate leaf widths up to 18 feet: 18.97 pounds per foot.
 - d) For gate leaf widths up to 23 feet: 28.55 pounds per foot.
 - d. Post Braces:
 - 1) Provide brace assemblies, each consisting of a steel pipe brace with a 3/4-inch diameter truss rod and an adjustable take-up device.



- 2) Nominal steel pipe Size: 1-1/4 inches.
 - 3) Weight: 2.27 pounds per foot, minimum.
 - e. Top Rail:
 - 1) Provide steel pipe.
 - 2) Nominal Size: 1-1/4 inches.
 - 3) Weight: 2.27 pounds per foot, minimum.
 2. Galvanize the pipe inside and outside using the hot dipped method to provide a minimum zinc coating of 1.8 ounce per square foot.
- B. Framing Accessories:
 1. Provide the following hot-dip zinc galvanized framing accessories conforming to the requirements of ASTM F 626:
 - a. Post Tops:
 - 1) Where barbed wire supporting arms are not required, provide pressed steel or malleable iron weather tight caps designed to cover the post ends and permit passage of the top rail.
 - b. Flat Tension Bars:
 - 1) Provide a 3/16-inch by 3/4-inch aluminum or galvanized steel one-piece stretcher bar equal in length to the full height of the fence fabric.
 - 2) Provide 1 stretcher bar for each gate and end post, and 2 bars for each corner and pull post.
 - 3) Provide 3/4 inch wide stretcher bar bands spaced not over 15 inches on center to secure the stretcher bars to the posts.
 - c. Bar Bands:
 - 1) Provide bar bands fabricated from steel plate and strip.
 - d. Barbed Wire Supporting Arms:
 - 1) Provide barbed wire supporting arms fabricated from formed steel shapes, and designed for 3 strands of barbed wire
 - 2) Provide barbed wire supporting arms of sufficient strength to withstand, without failure, a 250-pound downward pull at one end of the arm.
 - 3) Set the barbed wire supporting arms at a 45-degree angle toward the outside of the Site.
- C. Fabric and Wire:
 1. Fabric:
 - a. Provide wire fabric complying with the requirements for Class 2 fabric specified in ASTM A 392, and with the following:
 - 1) Wire Fabric: No. 9 gauge galvanized steel.
 - 2) Galvanizing: 2.0 ounces per square foot zinc coating, minimum.
 - b. Mesh Size and Style:
 - 1) Provide fabric interwoven in a 2-inch mesh with top knuckled selvage and bottom twisted selvage.
 2. Galvanized Barbed Wire:



- a. Provide barbed wire consisting of two 12-1/2-gauge stranded line wires, with 14-gauge round wire barbs in a four-point pattern on 5-inch centers.
 - b. Provide steel wire with a Class 3 galvanized coating complying with the requirements of ASTM A 121.
3. Tension Wire and Tie Wires:
 - a. Tension Wire:
 - 1) Provide 7-gauge galvanized steel wire.
 - 2) Galvanize tension wires in accordance with the requirements for Class 1 coating as specified in ASTM A 641/A 641M.
 - b. Tie Wires:
 - 1) Tie wire for fabric to line posts, rails, and braces; minimum 9 gauge and have the same wire and coating as tension wire.

D. Concrete:

1. Provide concrete complying with the requirements of Section 03300, Cast-In-Place Concrete.

2.04 GATES

A. Swing Gates:

1. Gate Frames:
 - a. Fabricate the swing gate frame in accordance with ASTM F 900.
 - b. Provide a swing gate frame consisting of nominal 2 inch tubular horizontal and vertical members, and if required truss members assembled by welding.
 - c. Galvanize the swing gate frame the same as the fence frame members.
 - d. Provide the same fabric as provided for the fence, and install it with stretcher bars and bar ties at 15 inches on center.
 - e. Provide diagonal cross bracing consisting of 3/8-inch diameter adjustable length truss rods.
 - f. Provide gate hardware attached using rivets or other means to provide security against its removal.
2. Gate Hardware:
 - a. Hinges:
 - 1) Provide pressed steel or malleable iron hinges to suit the gate size, of the non-lift-off type, and offset to permit 180-degree swing in or out.
 - 2) Provide 1 pair (top and bottom) per gate leaf.
 - b. Latch:
 - 1) Provide a forked or plunger bar type latch to permit operation from either side of the gate.
 - 2) Provide a padlock eye as an integral part of the latch.
 - 3) Provide gate stops for the pair of gates designed to accept a drop rod or plunger bar.



- c. Keeper:
 - 1) Provide keeper for each gate leaf to hold gate leaf in open position until manually released.
 - d. Barbed wire topping:
 - 1) Extend vertical members of the gate frame 12 inches, and attach barbed wire to the frame using tension bands to prevent the wire from moving out of position.
 - e. Padlocks:
 - 1) Provide padlocks having a corrosion resistant brass case and brass cylinders designed for outdoor use, a hardened steel shackle, and a 4-pin tumbler locking mechanism.
 - 2) Provide padlocks keyed alike and master keyed.
 - a) Provide 2 keys per padlock.
- B. Cantilever Slide Gates:
- 1. Provide cantilever slide gates designed for the opening dimensions indicated on the Contract Drawings and to be operated by a mechanical operator, and having a frame/enclosed track which slides along guide wheel assemblies attached to gate fence posts to guide the movement of the gate.
 - 2. Cantilever Slide Gate Frames:
 - a. Provide cantilever slide gate frames fabricated from 2-inch square 6063-T6 aluminum alloy tubing that weighs 0.94 pounds per lineal foot.
 - 1) Weld the corners of all frame members to form a rigid one-piece unit.
 - 2) The cantilever slide gate frames may be an integral part of the enclosed track in some configurations, depending on the manufacturer's design for the gate opening dimensions.
 - 3. Cantilever Slide Gate Enclosed Track:
 - a. The exact configuration of the enclosed track depends on the manufacturer and the opening dimension of the gate, but for most applications will be as follows:
 - 1) Provide an upper frame/guide track consisting of either 1 or 2 combination track and frame aluminum extrusions, depending on the manufacturer's design for the gate opening dimensions, each extrusion weighing 3.72 pounds per foot.
 - a) Weld dual extrusions into a single top member unit with a combined weight of 7.44 pounds per foot.
 - 2) Provide each track with the capacity to withstand a 2,000-pound reaction load.
 - b. Provide a lower rail consisting of either a 1-inch square or a 1-inch by 2-inch aluminum, depending on the manufacturer's design for the gate opening dimensions.
 - 4. Cantilever Slide Gate Fence Fabric:



- a. Provide the same fabric for the cantilever slide gates as provided for the adjacent fence.
 - 1) Securely stretch the fence fabric within the frame, and attach the fabric to the 2 inch square tubing on all four sides of the frame by using tension rods and hook bolts spaced 15 inches apart on center.
5. Cantilever Slide Gate Posts:
 - a. Provide 4-inch outside diameter Schedule 40 galvanized steel gate posts weighing 9.1 pounds per foot.
 - 1) Provide 3 gate posts for gates having a single enclosed track.
 - 2) Provide 5 gate posts for gates having dual enclosed tracks.
6. Cantilever Slide Gate Guide Wheel Assemblies:
 - a. Upper Roller Assembly:
 - 1) For each gate, provide at least 2 upper roller assemblies consisting of a swivel type zinc die cast truck, each having 4 vertical load bearing wheels, and to insure alignment of the truck in enclosed track 2 additional horizontal (side rolling) wheels.
 - a) Provide 2-inch diameter by 9/16-inch wide sealed lubricant, ball bearing wheels.
 - 2) Attach an upper roller assembly mounting bracket to the each supporting gate post using 7/8-inch diameter ball bolts with 1/2-inch shanks.
 - 3) Design the upper roller assembly to withstand the same reaction load as the enclosed track.
 - b. Lower Roller Assembly:
 - 1) For each gate, provide lower roller assemblies consisting of a steel angle-like bracket having 2 horizontal (side rolling) wheels that roll on either side of the lowest member of the cantilever slide gate frames to retain and align the gate.
 - a) Provide 4-inch diameter rubber wheels.
 - 2) Attach a lower roller assembly to the each supporting gate post using hardware similar to that used to attach the upper roller assemblies to the gate posts.
 - 3) Provide provisions to adjust the lower roller assemblies to maintain the gate frame plumb and in proper alignment.
7. Fabricate all gate hangers, latches, brackets, guide assemblies, and stops from malleable iron or steel, and galvanize them after fabrication.
8. Provide a mechanical operator to open and close the gate.
9. Provide a latch capable of positive latching and having provisions for padlocking.
10. Slide Gate Mechanical Operators:
 - a. Provide mechanical operators for slide gates each capable of operating a single gate and producing a gate speed of 60 feet per minute.



- 1) To prevent excessive wear on integral components in the event the gate becomes obstructed during the open or close cycle, provide an adjustable internal timer to limit the run time of the operator to a maximum of 90 seconds in any one direction.
- 2) To reduce the shock load on the operator, design the operator so a signal to reverse gate movement from any opening device delays reversal by 1.5 seconds.
- 3) Design the operator so any opening control device is capable of overriding the close circuit and can reverse the gate to the open position.
- 4) Design the operator with full systems capabilities so that additional control systems may be easily added in the field.
- b. Drive:
 - 1) Provide a rotary type drive capable of limiting gate travel in the open and close position.
 - 2) Provide accurate limit switches that are readily adjustable without the use of tools, and that can be securely locked in place after adjustment.
 - a) Provide switch contacts rated at 10 Amps.
- c. Motor:
 - 1) Provide a minimum 1 HP, 460-Volt, 3 phase, high torque, and heavy-duty reversible motor, separate from the reduction mechanism for easy maintenance.
 - 2) Protect the motor against overloads and under voltage by providing an external overload in the control panel, which is manually reset.
- d. Motor Starter:
 - 1) Provide a motor starter complying with the requirements for NEMA size "0" specified in NEMA ICS 2, and having a mechanical interlock.
 - 2) Pre-wire control circuits to a terminal block for ease of field installation.
 - 3) Include an open override design to provide complete control of the gate while it closes.
- e. Transformer:
 - 1) Provide a transformer having a primary rated 70 VA and a 24-Volt AC secondary.
 - 2) Wire all control devices to the 24-volt control.
 - 3) Provide control relays having silver cadmium oxide contacts rated at 10 Amps, 120 VAC.
- f. Reduction Mechanism:
 - 1) Provide a 20:1 "C" face worm gear speed reducer to reduce output speed capable of achieving a final output speed of 36 rpm via a number 50 nickel-plated drive chain and sprockets assembly.



- g. Brake:
 - 1) Provide a solenoid activated, disc type, adjustable locking brake.
- h. Gate Disconnect:
 - 1) To allow the gate to be operated manually in case of power failure, provide a means of disconnecting the mechanical operator from the gate without the use of tools.
 - 2) Use the operator cover to also protect the gate disconnect mechanism.
 - 3) In manual operation, provide a 1:1 drive ratio to allow fast operation of the gate.
- i. Mounting Pad:
 - 1) Mount the mechanical operator on a concrete pad having a minimum depth of 42-inches or below the local frost line.
 - 2) Install the mechanical operator on pad level and parallel to the fence line.
- 11. Sliding Gate Operating System:
 - a. Sliding Gate Controls:
 - 1) Provide a complete keyless entry system, including detector loops, conduits, and wiring as shown on the Contract Drawings and as necessary for a complete and satisfactory installation.
 - 2) Provide inner and outer detector loops embedded below grade as shown on the Contract Drawings, and associated timer controls, at each gate entrance.
 - a) Provide the inner loop at exits to activate the gate to open and allow free exit when a vehicle approaches to exit.
 - b) Provide the remaining loops to assure that the gate does not close when a vehicle is in contact with the loop area.
 - 3) Provide a cut out switch to override timer control of gate closing.
 - 4) Provide a lockable three button "Open", "Stop", and "Close" pushbutton inside the fence in the vicinity of each operator.
 - 5) Manufacturers:
 - a) Door King, Inc., www.doorking.com.
 - b) Approved equal.
 - b. Keyless Entry System:
 - 1) Card Reader:
 - a) Provide a slot less touch card reader in a pedestal-mounted, weather resistant, painted steel enclosure with stainless steel faceplate, weather shield, and lighted housing.
 - (1) Power:
 - (a) Provide a 12 Volt AC, 20 VA transformer to provide power.
 - (2) Memory:
 - (a) Provide non-volatile, EEPROM memory, not requiring reprogramming after a power loss.
 - (3) Relay Outputs:



- (a) Provide an 8 Amp/250 Volt AC entry control relay, and a 0.6 Amp/125 Volt AC alarm shunt relay.
- (4) Time Clock:
 - (a) Provide a time clock that adjusts for daylight savings time and leap year.
- b) Provide a programmable card reader, accessed through the use of a field changeable 6-digit security code entered via a keypad.
 - (1) Provide a system capable of accepting up to 100 cards.
 - (2) Provide a system allowing entry of 4 million possible codes.
 - (3) Anti-Pass back: Provide a system programmable from 1 to 30 minutes.
- c) Manufacturers:
 - (1) SecuraKey, www.securakey.com.
 - (2) Approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation:
 - 1. Do not begin installing chain link fences and gates prior to completing Site grading operations.

3.02 INSTALLATION

- A. Post Excavation:
 - 1. Drill holes for post footings in firm, undisturbed or compacted soil to a diameter equal to 4 times the diameter of the post
 - 2. Excavate holes to depths approximately 4 inches deeper than the post bottom, with the bottom of posts set not less than 36 inches in a concrete base.
- B. Fence Post Installation:
 - 1. Space posts a maximum of 10 feet apart on center.
 - 2. Install fence posts in the excavated holes.
 - 3. Check each post for vertical and top alignment.
 - 4. Place concrete in the holes around the posts in a continuous pour.
 - a. Set keepers, stops, sleeves, and other accessories as required into the concrete.
 - b. Tamp the concrete to consolidate.
 - c. Crown the tops of post footings to shed water or as detailed.
- C. Brace Installation:



1. Install braces so posts are plumb when diagonal rods are under proper tension.
2. Provide 2 brace assemblies at each corner post and 1 brace assembly at each end and gatepost.

D. Fence Fabric Installation

1. Install tension wires before stretching fabric, and tie the tension wires to each post with ties or clips.
2. Install fabric on the security side of the fence, and anchor the fabric to the framework so the fabric remains in tension after the pulling force is released.
 - a. Thread stretcher bars through the fabric, and secure it to the posts with metal bands spaced not over 15 inches on center.
 - b. Pull the fence fabric taut and tie it to braces, rails, and tension wires with wire ties spaced not over 24 inches on center.
3. Leave approximately 2 inches between the finished grade and the bottom selvage.

E. Barbed Wire Installation:

1. Install 3 parallel strands of barbed wire on each extension arm on the security side of the fence.
2. Pull the barbed wire taut, and firmly anchor the barbed wire in the slots of the line post extension arms.

F. Gate Installation:

1. Install gates plumb, level, and secure for the full opening without interference.
2. Install ground set items in concrete for anchorage, as recommended by fence gate manufacturer and as detailed.
3. Adjust hardware for smooth operation, and lubricate it where necessary.

G. Gate Operator Installation:

1. Install each gate operator in accordance with manufacturer's instructions and as indicated in Contract Documents.

H. Keyless Entry System/Card Reader Installation:

1. Install the keyless entry system/card reader in accordance with manufacturer's instructions.
2. The Owner will provide a list of cardholder's names.
3. Furnish cards from the system supplier coded to the list of cardholder's names provided, and program the system to accept the coded cards.

3.03 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Sliding Gate Test:



- a. Test Procedure:
 - 1) Test sliding gates to ensure they operate freely and properly prior to connecting the mechanical operator to the gate.
- b. Acceptance Criteria:
 - 1) Sliding gates that operate freely and properly are acceptable.

B. Manufacturer Services:

- 1. Furnish a representative from the keyless entry system/card reader system Supplier to verify correct operation of the coded cards.

3.04 CLEANING

- A. Clean up debris and unused material and remove it from the Site.

3.05 TRAINING:

- A. Furnish a representative from the keyless entry system/card reader system Supplier to instruct the Owner's personnel on the use of the system.

3.06 MAINTENANCE

- A. During the 1-year warranty period for the system, direct the fence Installer to perform quarterly (3 months) preventive maintenance checks using factory-trained technicians.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 02823

ORNAMENTAL METAL FENCES AND GATES - COATED

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for ornamental picket fencing and gates at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 787 - Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing.
 - 3. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low Alloy With Improved Formability Solution Hardened and Bake Hardenable.
 - 4. ASTM B 86 - Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings.
 - 5. ASTM B 695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Product Data for the ornamental fence.
 - 2) Color selections for polyester finishes.
 - b. Shop Drawings:
 - 1) Shop Drawings of the proposed ornamental fence layout.
 - c. Samples:
 - 1) Samples of ornamental fence materials (e.g. finials, caps, and other accessories).



- d. Qualification Statements:
 - 1) Ornamental fence and gate manufacturer's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Ornamental fence and gate manufacturer's installation instructions.
- C. Closeout Submittals:
 - 1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Ornamental fence and gate manufacturer's standard limited warranty.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer's Qualifications:
 - a. Procure ornamental fences and gates from a manufacturer having a minimum of 5 years' experience manufacturing ornamental picket fencing following the design, size, gauge of metal parts and fabrication specified.
 - b. Submit the ornamental fence and gate manufacturer's qualifications to the Program/Project Manager for approval.
- B. Site Samples:
 - 1. If requested by the Owner, provide Samples of materials (e.g. finials, caps, and other accessories).

1.05 MANUFACTURER WARRANTY:

- A. Provide manufacturer's standard limited warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering, and corroding for a period of 15 years from the date of purchase.
- B. Submit the ornamental fence and gate manufacturer's standard limited warranty to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers offering ornamental metal fence and gate products which can comply with the requirements of this Section include, but are not limited to, the following:
 - 1. Merchant Metals, Inc., www.merchantmetals.com.
 - 2. Master Halco, www.fenceonline.com.
 - 3. Approved equal.

2.02 DESIGN CRITERIA:

- A. Configuration:
 - 1. Install ornamental metal fence and gates at the locations indicated on the Contract Drawings.
 - a. Submit Shop Drawings of the proposed layout, and include the manufacturer's published details as modified to suit design and field conditions, and the layout of fence and gates with dimensions, details, and finishes of the component, accessories, and post foundations.
- B. Product Compatibility:
 - 1. Provide all ornamental metal fence components from one manufacturer.
 - a. Submit the manufacturer's Product Data for the products specified, including descriptive literature indicating material compliance and specified options, specifications, and installation information.
 - b. Submit color selections for polyester finishes.

2.03 COMPONENTS

- A. Rails:
 - 1. Provide 1-1/2-inch by 1-3/8-inch by 1-1/2-inch steel "U" channel rail members complying with the requirements of ASTM A 653/A 653M or ASTM A 1008/A 1008M.
 - a. Yield Strength: 50,000 psi.
 - b. Minimum Wall Thickness: 11 gauge (0.120 inch).
- B. Pickets:
 - 1. Provide square tubular steel picket members complying with the requirements of ASTM A 787.
 - a. Yield Strength: 45,000 psi.
 - b. Minimum Wall Thickness: 14 gauge.
 - 2. Minimum Size Picket: 3/4 inch.
 - 3. Picket Spacing: 4 inches on center.
- C. Posts:



1. Provide square tubular steel post members complying with the requirements of ASTM A 787.
 - a. Yield Strength: 45,000 psi.
 - b. Minimum Wall Thickness: 12 gauge (0.105 inch).
 - c. Minimum Post Size: 3 inches.
 - d. Post Weight: 4.286 pounds per foot.
- D. Flanged Posts:
 1. Provide flange type base plates with 4 holes for surface mounting posts where indicated or required.
- E. Rail Attachment Brackets:
 1. Provide die cast zinc ball and socket design rail attachment brackets complying with the requirements for alloy Z33520 as specified in ASTM B 86.
 2. Provide brackets that fully encapsulate the rail ends to provide complete security and be aesthetically pleasing.
 3. Provide brackets that are capable of swiveling 30 degrees to the left and right.
- F. Post Caps:
 1. Provide weathertight closure caps fabricated from formed steel, cast malleable iron, or aluminum alloy.
 2. Provide 1 ball style post cap for each post.
- G. Picket Tops:
 1. Provide flat picket tops having a polymer plug.
- H. Concrete:
 1. Provide concrete in accordance with the requirements of Section 03300, Cast-In-Place Concrete, and having a minimum 28-day compressive strength of 3000 psi.

2.04 FACTORY ASSEMBLY

- A. Assemble ornamental fence panels with ornamental accessories attached via tack welding, as shown on drawings.

2.05 FINISHES:

- A. Finish Materials:
 1. Galvanize the steel, applying a 0.90 ounce per square foot zinc coating in accordance with the requirements for a G90 Coating Designation as specified in ASTM A 653/A 653M.
 2. Finish Coat: Polyester resin based powder coating.
 - a. Color: Black.



B. Shop Finishing Methods:

1. After all steel components have been galvanized, clean and prepare the surface of all components to assure complete adhesion of finish coat.
2. Apply 2.5 mil thickness of polyester resin based powder coating by electrostatic spray process.
3. Bake the finish for 20 minutes at 450 degrees Fahrenheit metal temperature.
4. Galvanize each ferrous metal accessory item in accordance with ASTM B 695, and finish to match the framing.

2.06 ACCESSORIES

A. Industrial Drive Rivets:

1. Provide industrial drive rivets long enough to attach items in a secure non-rattling position.
2. Provide industrial drive rivets having a minimum holding power of 1100 pounds and shear strength of 1500 pounds.

B. Ornamental Picket Fence Accessories:

1. Provide indicated items required to complete the fence system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify that the areas to receive fencing are completed to the final grades and elevations indicated on the Contract Drawings.
2. Ensure property lines and legal boundaries of work are clearly established.

3.02 INSTALLATION

A. Install fence in accordance with manufacturer's installation instructions.

1. Submit the manufacturer's installation instructions to the Program/Project Manager for information.

B. Space posts uniformly at the face to face dimension indicated in the approved Shop Drawings.

C. Set Concrete Posts:

1. Drill a hole on firm, undisturbed or compacted soil.
2. Drill holes to have a diameter 4 times greater than nominal outside dimension of the post, and to a depth approximately 6 inches deeper than post bottom.
 - a. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.



3. Set the post bottom 36 inches below the surface when in firm, undisturbed soil.
 4. Place concrete around the post in a continuous pour.
 5. Trowel finish around posts and slope to direct water away from posts.
- D. Check each post for vertical and top alignment, and maintain them in position during placement and finishing operations.
- E. Align fence panels between posts.
- F. Firmly attach rail brackets to post using 1/4-inch bolt and lock nut, ensuring panels and posts remain plumb.
- G. Install post caps and other accessories to complete the fence installation
- H. Gate Posts and Hardware:
1. Set keepers, stops, sleeves, and other accessories into concrete.
- I. Wall Mounted Posts:
1. Surface mount (wall mount) posts with mounting plates where indicated.
 2. Fasten mounting plates with lag bolts and shields.

3.03 CLEANING

- A. Clean up debris and unused material, and remove them from the Site.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition
1	04/19/2018	N/A	All	Name Change to include descriptor "Coated". Specification has been modified to delete Stainless Steel references, clarifies coating requirements.



SECTION 02824

ORNAMENTAL METAL FENCES AND GATES – STAINLESS-STEEL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for ornamental picket fencing and gates at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 02300 – Earthwork.
 - 5. Section 03300 - Cast-In-Place Concrete.
 - 6. Section 04810 Unit Masonry Assemblies

1.02 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM):
 - 1. City of Phoenix Building Construction Code
 - 2. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - 3. ASTM A 123/A 653M - Standard Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products.
 - 4. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 5. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - 6. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 7. ASTM B 695 - Standard Specification for Coatings of Zinc Mechanically deposited on Iron and Steel.
 - 8. ASTM A 787 - Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing.
 - 9. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low Alloy With Improved Formability Solution Hardened and Bake Hardenable.
 - 10. ASTM B 86 - Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings.
 - 11. ASTM B 695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 12. ASTM A554-Standard Specification for Welded Stainless Steel.



13. ASTM A276-Standard Specification for Stainless Steel Bars and Shapes
14. ASTM A 240 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
15. ASTM A 666 Annealed or Cold Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Product Data for the Ornamental fence and Gates.
 - 2) Color selections for finishes.
 - b. Shop Drawings:
 - 1) Shop Drawings of the proposed Ornamental fence and Gates layout.
 - c. Samples:
 - 1) Samples of Ornamental fence and Gates materials (e.g. finials, caps, and other accessories) components.
 - d. Qualification Statements:
 - 1) Ornamental fence and Gate manufacturer's qualifications.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Ornamental fence and Gate manufacturer's installation instructions.

C. Closeout Submittals:

1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Ornamental fence and Gate manufacturer's standard limited warranty.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer's Qualifications:
 - a. Procure Ornamental fences and Gates from a manufacturer having a minimum of 5 years' experience manufacturing Ornamental fencing



and Gates following the design, size, gauge of metal parts and fabrication specified.

- b. Submit the Ornamental fence and Gate manufacturer's qualifications to the Program/Project Manager for approval.

B. Site Samples:

1. If requested by the Owner, provide Samples of materials (e.g. finials, caps, and other accessories).

1.05 MANUFACTURER WARRANTY:

- A. Provide manufacturer's standard limited warranty that its Ornamental fence and Gate system is free from defects in material and workmanship including cracking, peeling, blistering, and corroding for a period of 15 years from the date of purchase.
- B. Submit the Ornamental fence and Gate manufacturer's standard limited warranty to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers offering Ornamental metal fence and Gate products which can comply with the requirements of this Section include, but are not limited to, the following:
 1. Brooklyn Stainless Steel <http://www.brooklynstainlesssteel.com>
 2. Quality Stainless Steel www.qualitystainlesssteel.com
 3. Approved equal.

2.02 DESIGN CRITERIA:

- A. Configuration:
 1. Fabricate and install Ornamental metal fence and Gates at the locations indicated on the Contract Drawings.
 - a. Submit Shop Drawings of the proposed layout, and include the manufacturer's published details as modified to suit design and field conditions, and the layout of fence and gates with dimensions, details, and finishes of the component, accessories (including but not limited to Automatic Gate Opener, Automatic Gate Controller and Wireless Push Pad Opener), and post foundations.

Note: all work associated with the Ornamental Fence and Gate construction shall be designed to be in compliance with City of Phoenix Building Construction Code and any issued amendments to this code.
- B. Product Compatibility:



1. Provide all Ornamental metal fence and Gate components from one manufacturer.
 - a. Submit the manufacturer's Product Data for the products specified, including descriptive literature indicating material compliance and specified options, specifications, and installation information.
 - b. Submit color selections for all finishes.
 - c. Submit all data to the Program/Project Manager for review and approval.

2.03 COMPONENTS

- A. Materials:
 1. Post and Caps: Stainless Steel Posts and Caps shall be 2" Schedule 80
 2. Rails: Stainless Steel Rails shall be 2" Schedule 80
 3. Intermediate Rails: Stainless Steel Intermediate Rails shall be ½" Schedule 80
 4. Flat Bar Intermediate Post: Stainless Steel Flatbar ½" Thick
 5. Flat Bar Weld Plate: Stainless Steel ½" x 7 1/2" Flat Bar Wall Cap/Weld Plate
- B. Concrete:
 1. Provide concrete in accordance with the requirements of Section 03300, Cast-In-Place Concrete, and having a minimum 28-day compressive strength of 3000 psi.

2.04 ASSEMBLY

1. Fence and Gate Components Rails:
 - a. Provide rails fabricated from Stainless Steel tubing complying with the requirements as indicated on the Contract Drawings
2. Pickets:
 - a. Provide pickets fabricated from Stainless Steel tubing complying with the requirements as indicated on the Contract Drawings
3. Gates:
 - a. Provide frames for gates having sufficient size and thickness to provide adequate support without sag.
 - a) Adjustable trussing may be required.
 - b. Provide gate hardware from the manufacturer of sufficient size and capacity to support the gate specified.
 - c. Provide all required materials and electrical connections for the specified automatic gate opener, control panel, and wireless push pad openers.
4. Posts:
 - a. Provide fence posts and caps fabricated from Stainless Steel tubing complying with the requirements as indicated in the Contract Drawings



2.05 FABRICATION

1. Shop Fabrication:
 - a. Fabricate the panels, gates, and posts using Stainless steel complying with the requirements in the ASTM standards specified, and from new prime material.
 - b. Welded Construction:
 - 1) Provide panels, gates, and flanged posts fabricated using the gas metal arc welding method.
 - a) No wire rods, screws, or rivets are acceptable for attaching the pickets to the rails.
 - 2) Have experienced craftsmen perform the layout and welding.
 - 3) Provide welds that are neat, clean and of the sizes indicated on the Contract Drawings.
 - a) Grind flush welds smooth.

2.06 FINISHES:

- A. Finish Materials:
 1. Stainless Steel Finish Shall be Brushed Number 04 for all components.

2.07 ACCESSORIES

- A. Ornamental Fence and Gate Accessories:
 1. Provide indicated items required to complete the Ornamental fence and Gate system including the automatic gate opener, automatic gate controller, and wireless push button gate openers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the areas to receive fencing are completed to the final grades and elevations indicated on the Contract Drawings.
 2. Ensure property lines and legal boundaries of work are clearly established.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the Ornamental Metal Fences and Gates.
- B. Surface Preparation:
 1. Perform excavations for Ornamental Metal Fence and Gate posts in accordance with the requirements specified in Section 02300, Earthwork.



3.03 INSTALLATION

- A. Install fence in accordance with manufacturer's installation instructions and as indicated on the Construction Documents.
 - 1. Submit the manufacturer's installation instructions to the Program/Project Manager for information.
- B. Space posts uniformly at the face to face dimension indicated in the approved Shop Drawings.
- C. Set Concrete Posts:
 - 1. As indicated on the construction documents
 - 2. Align all fence panels between the Ornamental Fence Posts as shown on the construction documents
- D. Check each post for vertical and top alignment, and maintain them in position during placement and finishing operations.
- E. Weld fence panels to the Ornamental fence posts.
 - 4. When field welding a rail to a post, provide a complete 360 degree weld (all four sides) of the size indicated on the Contract Drawings.
- F. Install post caps and other accessories to complete the fence installation
- G. Gate Posts and Hardware:
 - 1. Set keepers, stops, sleeves, and other accessories into concrete. Note install Gate Stops if required by PSHIA.
 - 2. Install gates plumb and level, and of the sizes and style indicated on the Contract Drawings.
 - 3. Field-attach padlock provisions or strikes to assure alignment.
 - 4. Lubricate the hinges, rollers, and other gate hardware after installation
- H. Wall Mounted Posts:
 - 1. Surface mount (wall mount) posts as indicated on the contract drawings.

3.04 CLEANING

- A. Clean all concrete residue from all exposed Ornamental Fencing and Gate materials
- B. Waste Management
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 - 2. Scatter or remove post hole excavations uniformly away from the posts as directed by the Program/Project Manager.
- C. Clean up debris and unused material, and remove them from the Site.

**END OF SECTION**

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition
1	04/19/2018	N/A	This	J2 Edits for Stainless Steel Specification for Dog Fence
			1.02.A	Add Stainless ASTM Standard Specification Numbers
			2.01.A	Corrections to Manufacturers list.
			2.02.A.1.a	Added clarification to Shop Drawings requirements
			2.03.A	Corrections to Materials
			2.07.A.1	Added detail to indicated items.





SECTION 02825

WIRE ROPE SECURITY FENCE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for wire rope security fence (WRSF).
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 03100 - Concrete Forms and Accessories.
 - 4. Section 03200 - Concrete Reinforcement.
 - 5. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. MBL: Minimum breaking load.
 - 2. WRSF: Wire rope security fence.
- B. Definitions:
 - 1. Tufftride Process: Nitride hardening, a chemical process using a salt bath to change the surface characteristics of metals.
- C. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M 30 - Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail.
 - 2. American National Standards Institute (ANSI):
 - a. ANSI B1.13M – Metric Screw Threads – M Profile.
 - 3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - 4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 741 - Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail.
 - 5. City of Phoenix (COP):



- a. Aviation Department:
 - 1) S.O.P. Number 4.19.00 – Standard Operating Procedures: Perimeter Fence, Gates, and Doors.
- 6. State of Arizona:
 - a. Arizona Revised Statutes (ARS):
 - 1) ARS 40-360.21 through 32 - Chapter 2 Public Service Corporations Generally, Article 6.3, Underground Utilities,
 - 2) ARS 40-360.41 through 45 - Chapter 2 Public Service Corporations Generally, Article 6.4, High Voltage Power Lines and Safety Restrictions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Excavation Safety:
 - a. At least 3 days prior to the start of digging or excavation Work, contact Arizona Blue Stake at (602) 263-1100 to arrange for utility owners to locate and mark their underground utilities.
 - 1) Comply with applicable Arizona Revised Statutes (ARS), especially those regarding Underground Utilities and the Overhead Powerline Safety Law.
 - 2) If unexpected active underground facilities are encountered during the performance of the Work, notify the Program/Project Manager immediately.
 - b. Sole responsibility for making all excavations in a safe manner is the Contractor's.
 - c. Provide suitable protection against bodily injury.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Wire rope security fence concrete mix design.
 - 2) Wire rope security fence concrete reinforcement.
 - 3) Wire rope security fence fittings.
 - 4) Wire rope security fence posts.
 - 5) Wire rope security fence sockets.
 - 6) Wire rope security fence wire rope.
 - b. Shop Drawings:
 - 1) Wire rope security fence layout and anchorage details.
 - c. Certificates:
 - 1) Manufacturers' Certificates of Compliance for wire rope, anchor posts, corner posts, and line posts.



- d. Qualification Statements:
 - 1) Welding procedure specifications (WPS) test records.
 - 2) Welding Certificates.
 - 3) Wire rope security fence installer's qualifications.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Wire rope safety fence manufacturer's installation instructions.
 - 2) Wire rope safety fence manufacturer's wire rope placing and tensioning recommendations.
 - b. Manufacturer's Reports:
 - 1) Wire rope, anchor post, corner post, and line post manufacturers' material test reports.

1.05 QUALITY ASSURANCE

A. Qualifications:

- 1. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - a) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in AWS D1.1/D1.1M.
 - 2) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.



2. Wire Rope Security Fence Installer's Qualifications:
 - a. Employ an experienced wire rope security fence installer who has completed wire rope security fence installations that were similar in material, design, and extent to that indicated for this Contract at this or other airports, and which exhibits a record of successful in-service performance.
 - 1) Submit the wire rope security fence installer's qualifications to the Program/Project Manager for approval.

B. Certifications:

1. Manufacturers' Certificates of Compliance:
 - a. Submit certification from the manufacturers of the wire rope, anchor posts, corner posts, and line posts certifying compliance with the requirements specified to the Program/Project Manager for approval.
2. Manufacturers' Material Test Reports:
 - a. Submit material test reports from the manufacturers of the wire rope, anchor posts, corner posts, and line posts indicating compliance with the requirements specified to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Delivery Requirements:
 - a. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - b. Wire Rope:
 - 1) Suitably wrap, package, and/or cover wire rope at the factory to prevent physical damage and deleterious corrosion during transportation.
 - c. Ship small parts, such as bolts, nuts, washers, and small connecting plates and anchors, in boxes, crates, or barrels.
 - 1) Plainly mark an itemized list and description of the contents on the outside of each container.
2. Acceptance Requirements:
 - a. Have the wire rope security fence installer inspect the components and accessories at the time of delivery to the Site and prior to placement.
 - 1) Notify the Program/Project Manager of observed damages immediately.
 - b. Surface Condition:
 - 1) If surface rust is present, remove it with a fine steel wool pad or by vigorously rubbing it with a cloth.
 - 2) Remove and discard lengths of wire rope containing broken or corroded wires.



B. Storage and Handling Requirements:

1. Store wire rope security fence components on platforms, skids, blocking, or other supports to prevent contact with dirt, debris, and moisture.
2. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
3. Keep wire rope security fence components dry.
 - a. Place steel stored at the Site above the ground on elevated covered platforms.
 - 1) Do not expose steel materials to water and/or dirt.
4. Do not expose wire rope stored more than one month to direct sunlight.
5. Handle wire rope security fence components with special care so no posts are bent, broken, or otherwise damaged; and avoid damage to other material.
 - a. Replace damaged components, unless the Program/Project Manager authorizes repairs.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not perform excavating, backfilling, or compacting operations when either weather conditions or the condition of the materials are such, in the opinion of the Program/Project Manager, that the work cannot be performed satisfactorily.
2. Provide effective dust control measures on the Site to prevent the spread of dust during earthwork operations.
 - a. Thoroughly moisten excavation areas by dampening the soil, or employ other similar methods as approved by the Program/Project Manager.

B. Existing Conditions:

1. It is the Contractor's responsibility to satisfy itself regarding the actual soil classification and condition, the water table, and the amount of rock, gravel, sand, silt, clay, and water, to be encountered during the Work of this Section.
2. Assume the risks attending to the presence or proximity, if any, of overhead or underground public utility and private lines, pipes, conduits and their associated support work, and other structures and property of every kind and description, in or over the excavation, or in the vicinity of the work, whether above or below the surface of the ground.



PART 2 PRODUCTS

2.01 SYSTEMS

A. Manufacturer List:

1. Brifen USA, Inc., www.brifenusa.com.
2. Approved equal.

B. Description:

1. Provide interwoven 4-rope type wire rope security fence (WRSF) in which the ropes are each woven on alternating sides of sequential socked line posts for the entire length of the fence segment.
 - a. Provide interwoven wire rope security fence having each rope placed on the opposite side of the line posts as the next higher rope.
2. Regulatory Requirements:
 - a. If installation of the work under this Section involves an addition, alteration, or deletion of a fence or wall that forms part of the perimeter fence line between a public area and a restricted area at the Phoenix Sky Harbor International Airport, comply with the requirements of the City of Phoenix (COP) Aviation Department's S.O.P. Number 4.19.00.

C. Performance:

1. Threaded Terminals:
 - a. Provide threaded terminals so fully fitted ropes are capable of developing a minimum breaking load (MBL) of 36,800 pounds force (16.7tonne).
2. Turnbuckles/Rigging Screws:
 - a. Provide turnbuckles/rigging screws capable of developing a minimum tensile load of 36,800 pounds force (16.7tonne) without yielding.
3. Mechanical Anchor Fittings:
 - a. Provide mechanical anchor fittings capable of developing a minimum tensile load of 36,800 pounds force (16.7tonne) of the entire wire rope without yielding.

D. Design Criteria:

1. Post Foundations:
 - a. Determine the size of foundations for the anchor posts, the corner posts at changes of direction, and the line posts based on the classification and condition of the soil, the water table, and expected temperature extremes and other climatic conditions, at the Site.
2. Threaded Terminal Fittings:
 - a. Design threaded terminal fittings so their bodies engage a minimum depth of 5.9 inches (150mm) of wire rope.
3. Line Posts:
 - a. Design line posts to be capable of holding the wire ropes at the design height indicated on the drawings attached to the end of this Section.



- b. Provide line posts designed to be placed in a metal sleeve installed in a socketed foundation.
 - 4. Product Data:
 - a. Submit the manufacturer's Product Data for each product specified and provided under this Section to the Program/Project Manager for approval.
 - b. Submit the manufacturer's installation instructions for each product specified to the Program/Project Manager for information.
 - 5. Shop Drawings:
 - a. Submit detailed Shop Drawings showing the layout of wire rope security fence and anchorage details to the Program/Project Manager for approval.
- E. Components:
 - 1. Concrete:
 - a. Provide concrete complying with the requirements specified for Class AA concrete in Section 03300, Cast-In-Place Concrete.
 - 2. Concrete Reinforcement:
 - a. Provide concrete reinforcement complying with the requirements specified in Section 03200, Concrete Reinforcement.
 - 3. Wire Rope Security Fence Fittings:
 - a. Threaded Terminals:
 - 1) Provide galvanized swaged type M24 X 3 threaded terminals threaded in accordance with the requirements specified in ANSI B1.13M for the ends of the wire rope.
 - a) Nominal size coarse pitch: 3.
 - b) The threaded terminals may be either shop or field swaged.
 - c) Galvanize the threaded terminals in accordance with the requirements specified in ASTM A 153/A 153M after threading.
 - d) Provide right hand (RH) and left hand (LH) threaded terminals as required.
 - b. Turnbuckles/Rigging Screws:
 - 1) Provide galvanized turnbuckles, also known as rigging screws, of the sizes and shapes indicated on the drawings attached to the end of this Section that allow a minimum 6-inch penetration of wire rope on each end.
 - a) Provide either solid or closed body type turnbuckles having 2 inspection holes designed to allow the terminal penetration of the threaded rope to be determined.
 - b) Galvanize the turnbuckles in accordance with the requirements specified in ASTM A 153/A 153M after threading.
 - 2) Provide turnbuckles having one end threaded right hand and the other end threaded left hand with M24 X 3 threads complying with the requirements specified in ANSI B1.13M.



- c. Mechanical Anchor Fittings:
 - 1) Provide mechanical anchor fittings consisting of a cylindrical barrel with a tapered interior bore into which the wire rope can be inserted from the narrower end, a set of grooved wedges which can be inserted from the opposite end between the barrel and the wire rope, a coil spring, and a screw on cap.
 - 2) Design the mechanical anchor fittings so the coil spring is compressed against the grooved wedges when the cap is screwed onto the wider end of the barrel, thus exerting force on the wedges to prevent an accidental release of the wedges while tension in the wire rope pulls the wedges tighter around the wire rope.
 - a) Provide mechanical anchor fittings capable of infinite adjustment along the wire rope for proper length.
 - b) Provide mechanical anchor fittings capable of release and reuse.
 - 3) Coat the mechanical anchor fittings using the Tufftride process and wax oil for protection.
- 4. Fence Posts:
 - a. Line, End Anchor, and Corner Posts:
 - 1) Provide line posts of the sizes and shapes indicated on the drawings attached to the end of this Section, fabricated from domestic hot rolled steel complying with the requirements specified in ASTM A 36/A 36M, and galvanized in accordance with the requirements specified in ASTM A 123/A 123M or powder-coated after fabrication.
 - a) Pre-drill 17/64-inch holes in the posts to accept wire rope locating pegs as shown on the drawings.
 - b) After galvanizing, clean the holes in the posts for the wire rope locating pegs.
 - 2) For driven post assemblies only, provide soil plates fabricated from 3/16 inch thick steel welded to the driven post.
 - b. Wire Rope Locating Pegs:
 - 1) Provide the manufacturer's standard locating pegs.
 - c. Excluders:
 - 1) Provide a low-density polyethylene excluder profiled to fit tightly around each post to prevent debris from entering the sockets in the post foundations.
 - d. Post Caps:
 - 1) Provide black low-density polyethylene post caps designed to fit on the top of posts.
- 5. Sockets:
 - a. Provide sockets placed in concrete foundations as shown on the drawings attached to the end of this Section.



- 1) Fabricate the sockets placed in concrete foundations from 10 gage, minimum, hot rolled mild steel complying with the requirements specified in ASTM A 36/A 36M, and galvanized in accordance with the requirements specified in ASTM A 123/A 123M after fabrication.
 - a) Provide either steel or polyethylene bottom end closure for sockets.
 - b) Provide concrete reinforcement for the concrete foundations consisting of 8-inch (200mm) diameter reinforcing rings having a 4-inch overlap made from number 3 deformed rebar and other reinforcement as shown on the drawings attached to the end of this Section.
6. Wire Rope:
 - a. Provide galvanized wire rope complying with the requirements for Type I Guard Cable as specified in Table 1 in AASHTO M 30/ASTM A 741, and having a Class A Coating as specified in Table 2 in AASHTO M 30/ ASTM A 741, except as modified herein:
 - 1) Minimum Diameter: 3/4 inch (19mm).
 - 2) Construction: 3 by 7 (the number of strands by the number of wires per strand).
 - 3) Minimum Breaking Strength: 39,000 pounds force (17.7tonne).
 - b. Minimum Modulus of Elasticity:
 - 1) Provide wire rope that has been pre-stretched during its manufacture so that after the pre-stretching the rope exhibits a minimum modulus of elasticity of 11,805,090 pounds per square inch (8300 kg/mm²).
- F. Shop Fabrication:
 1. Perform all welding in accordance with the requirements specified in AWS D1.1/D1.1M.

2.02 ACCESSORIES

- A. Retroreflective Sheeting:
 1. If retroreflective sheeting is required on posts, provide sheeting of the color and spacing required by the Owner, and properly sized to fit the traffic approach side of the line post.
- B. Prismatic Reflectors:
 1. If prismatic reflectors are required, provide adhesive backed double sided reflectors of the color(s) selected by the Program/Project Manager suitable for field application.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the area where the wire rope security fence is to be installed to verify it is relatively smooth, without drop-offs, holes, depressions, or abrupt slope changes.
 - 2. Determine actual soil conditions, which may differ from those anticipated or indicated by available soil logs and/or reports.
- B. Evaluation and Assessment:
 - 1. Notify the Program/Project Manager of unexpected subsurface conditions, and discontinue working in the affected area until notified to resume work.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Before starting to install the wire rope safety fence, grade the area smooth and perform necessary filling and compaction.

3.03 INSTALLATION

- A. Locate and align the wire rope security fence in accordance with the Contract Drawings and as directed by the Program/Project Manager.
- B. Foundations:
 - 1. Concrete Foundations:
 - a. Either excavate holes having vertical sides and flat bottoms for the foundations in natural, undisturbed ground to the size and shape indicated on the drawings attached to the end of this Section, install concrete reinforcement, and place concrete in the excavation completely filling the excavation; or alternatively form the foundation in accordance with the requirements of Section 03100, Concrete Forms and Accessories, install concrete reinforcement, cast the foundation, remove the forms, and backfill and compact the backfill to a minimum density of 95 percent.
 - 1) Provide concrete reinforcement as indicated on the drawings attached to the end of this Section.
 - b. Ensure that the sockets are installed flush with the top of the foundations.
- C. Posts:
 - 1. Provide posts of the type indicated on the Contract Drawings and on the drawings attached to the end of this Section.
 - a. Unless otherwise indicated, place line posts in sockets set in concrete foundations.



- 1) Install driven post assemblies only where specifically indicated on the Contract Drawings.
 - b. Space the posts as indicated on the Contract Drawings and/or on the drawings attached to the end of this Section.
 - c. Set the posts plumb and in line.
2. Ensure that the radiused edges of the posts are on the side of approaching traffic.
3. Install the excluders tight against the top of the sockets.

D. Wire Rope:

1. Place the wire rope and fittings and tension the wire rope as recommended by the wire rope safety fence manufacturer.
 - a. Submit the wire rope safety fence manufacturer's placing and tensioning recommendations to the Program/Project Manager for information.
2. Provide wire rope at the wire heights indicated on the drawings attached to the end of this Section so an aesthetically pleasing line of sight is produced.
3. When changes of direction are required, carry the ropes around corner posts.
4. At end anchor posts, secure the wire ropes inside the posts to prevent unauthorized access.
 - a. At the end anchor posts where threaded terminals on the end of the wire ropes are not feasible, provide mechanical anchor fittings.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Galvanized Coating Test:
 - a. Test Procedure:
 - 1) The galvanized components will be tested at the Site to determine the weight of the galvanized coating using a magnetic gage.
 - b. Acceptance Criteria:
 - 1) Galvanized components having at least the minimum specified weight of galvanized coating will pass the Galvanized Coating Test.
2. Inspections:
 - a. The wire rope will be visually inspected for its condition and conformance with dimensional and other requirements.

B. Non-Conforming Work

1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.



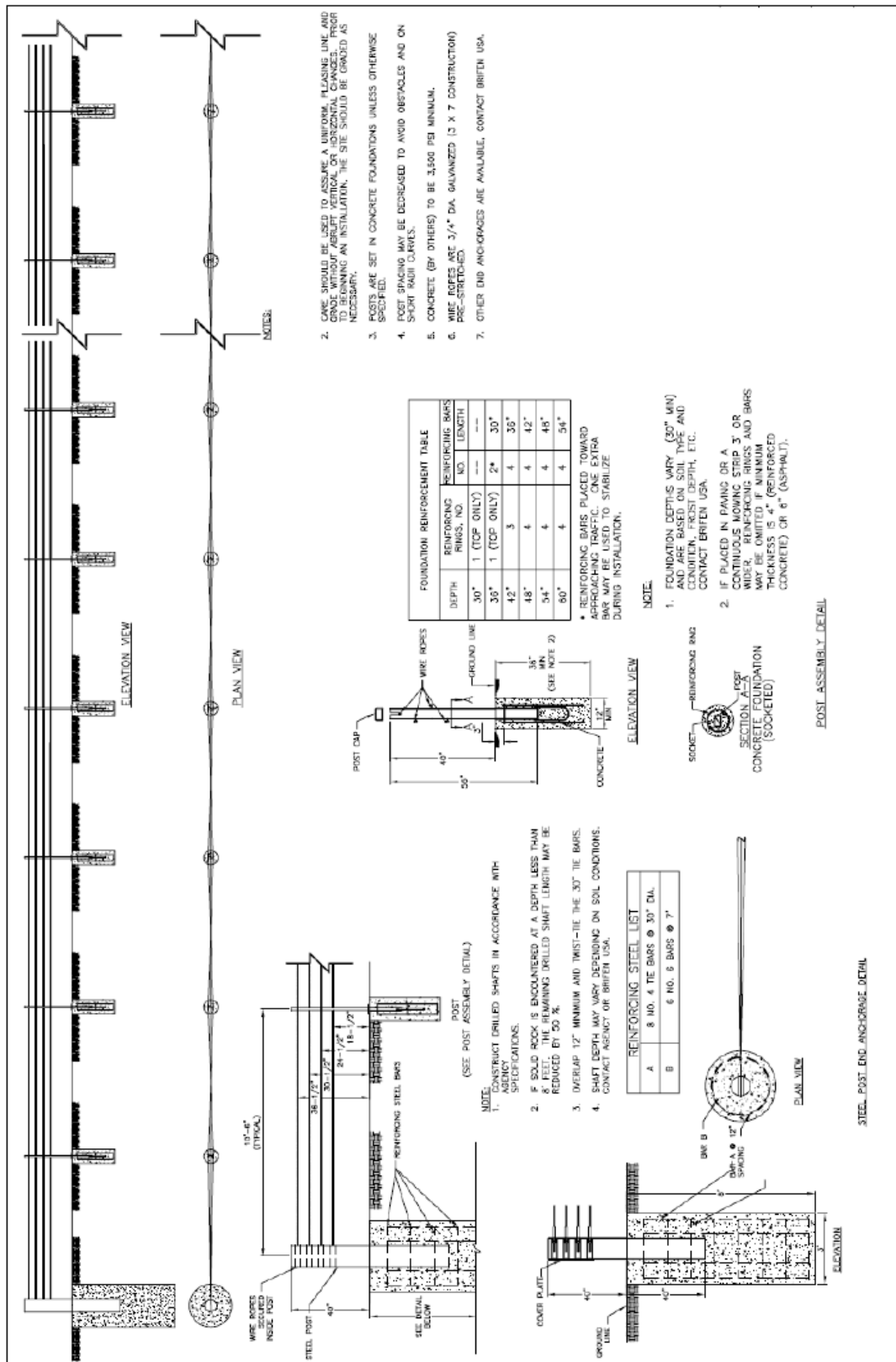
3.05 CLEANING

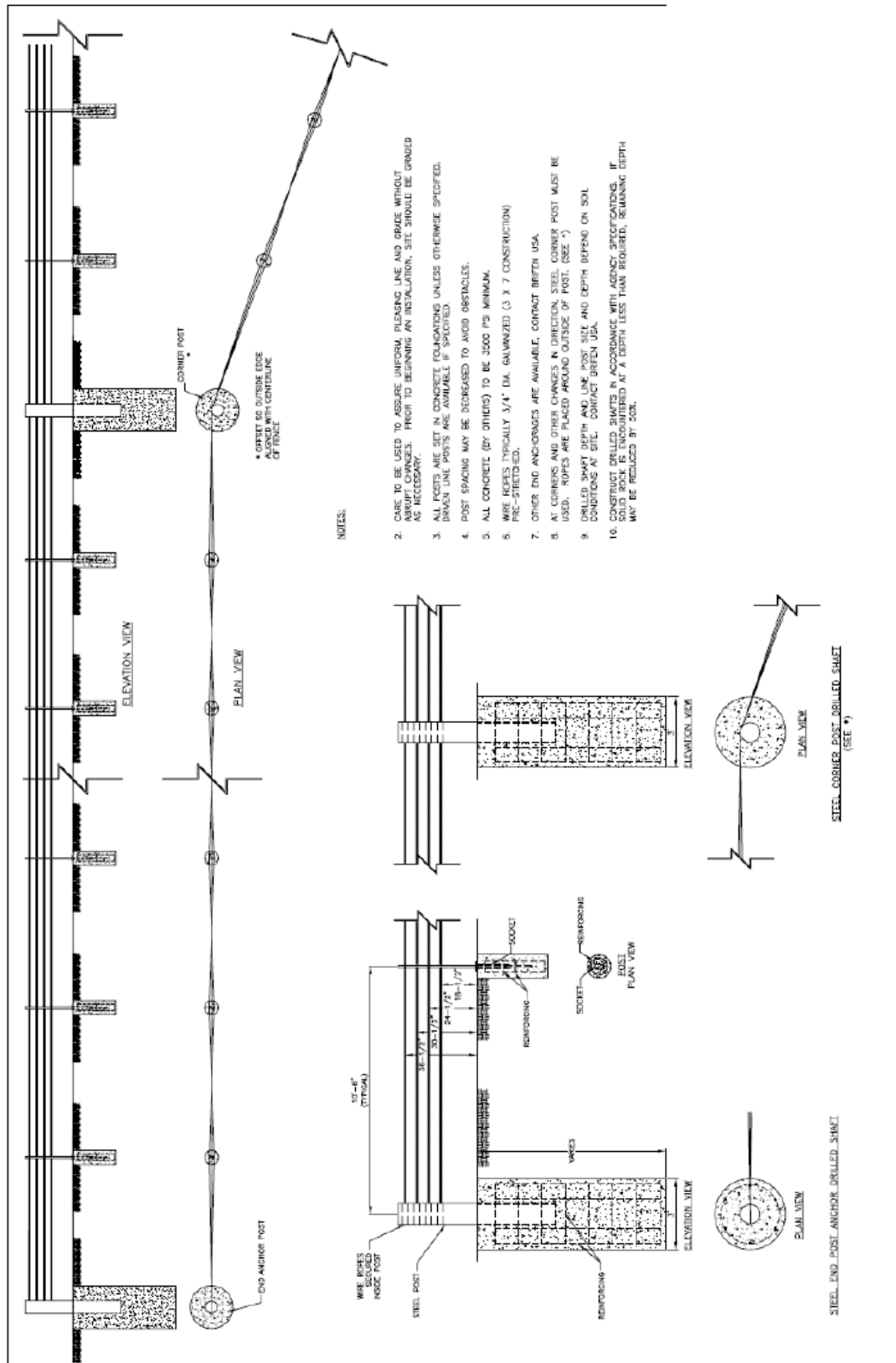
- A. Clean up debris and unused material, and remove them from the Site.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

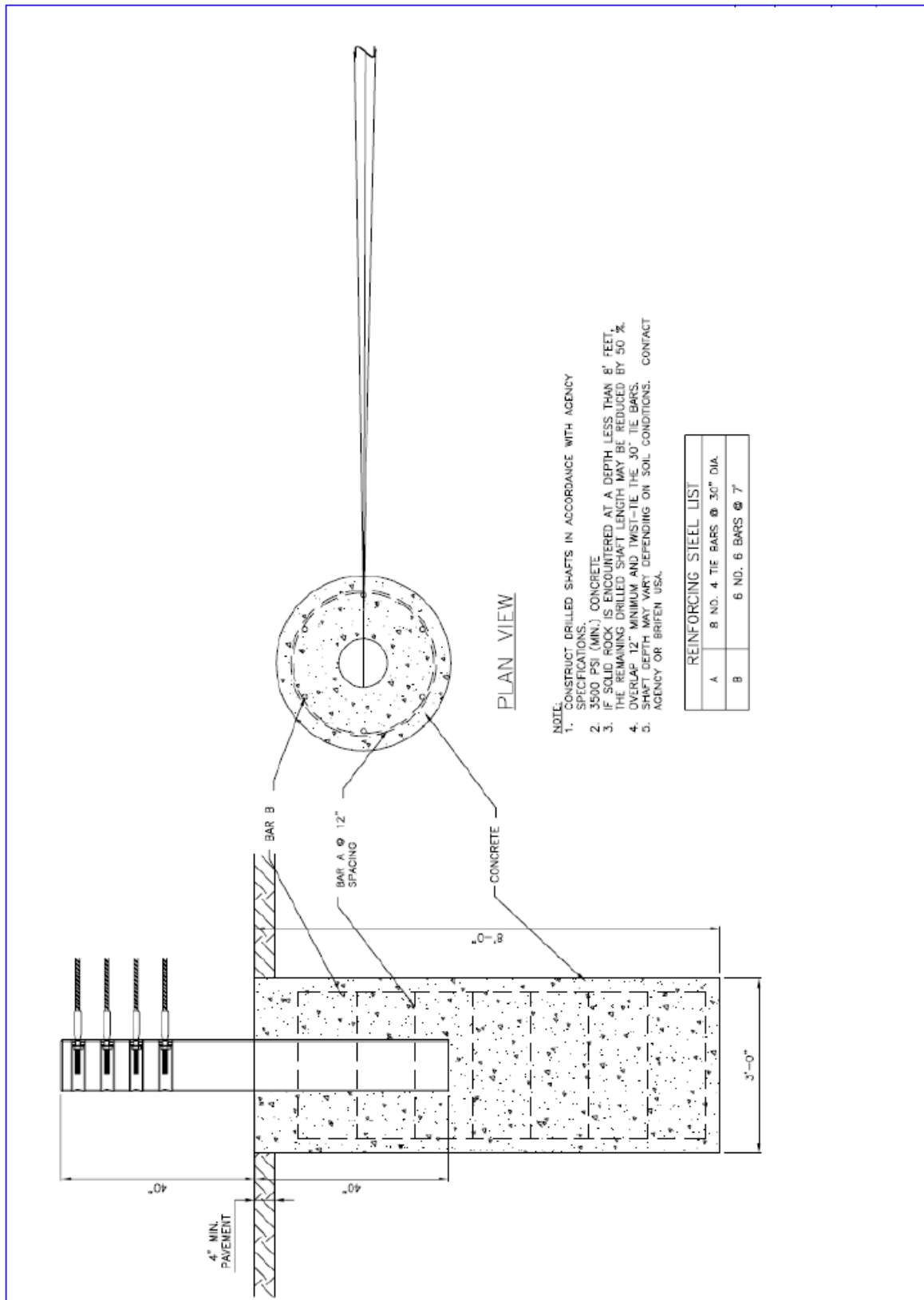
3.06 ATTACHMENTS

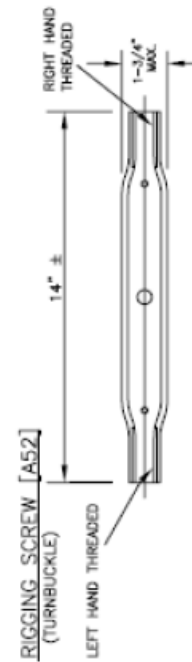
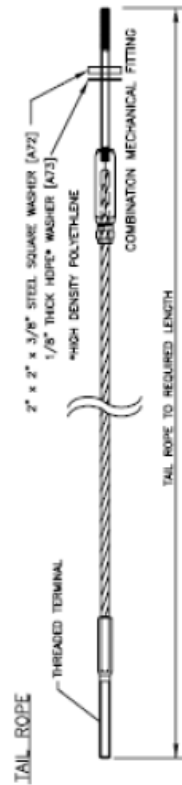
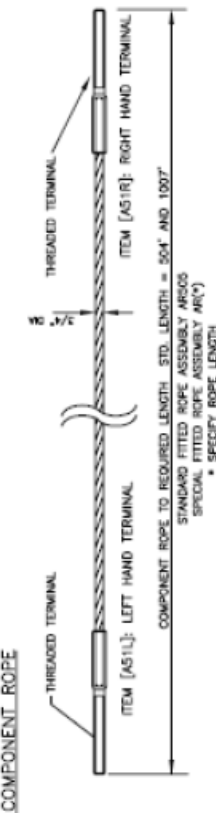
- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
 - 1. General Layout Wire Rope Security Fence.
 - 2. General Layout Four-Rope Security Fence (36 – 1/2”).
 - 3. Steel Post End Anchorage (Drilled Shaft) (3’ Dia X 8’ Deep).
 - 4. Wire Rope and Fittings.
 - 5. Socketed Post Detail.

END OF SECTION





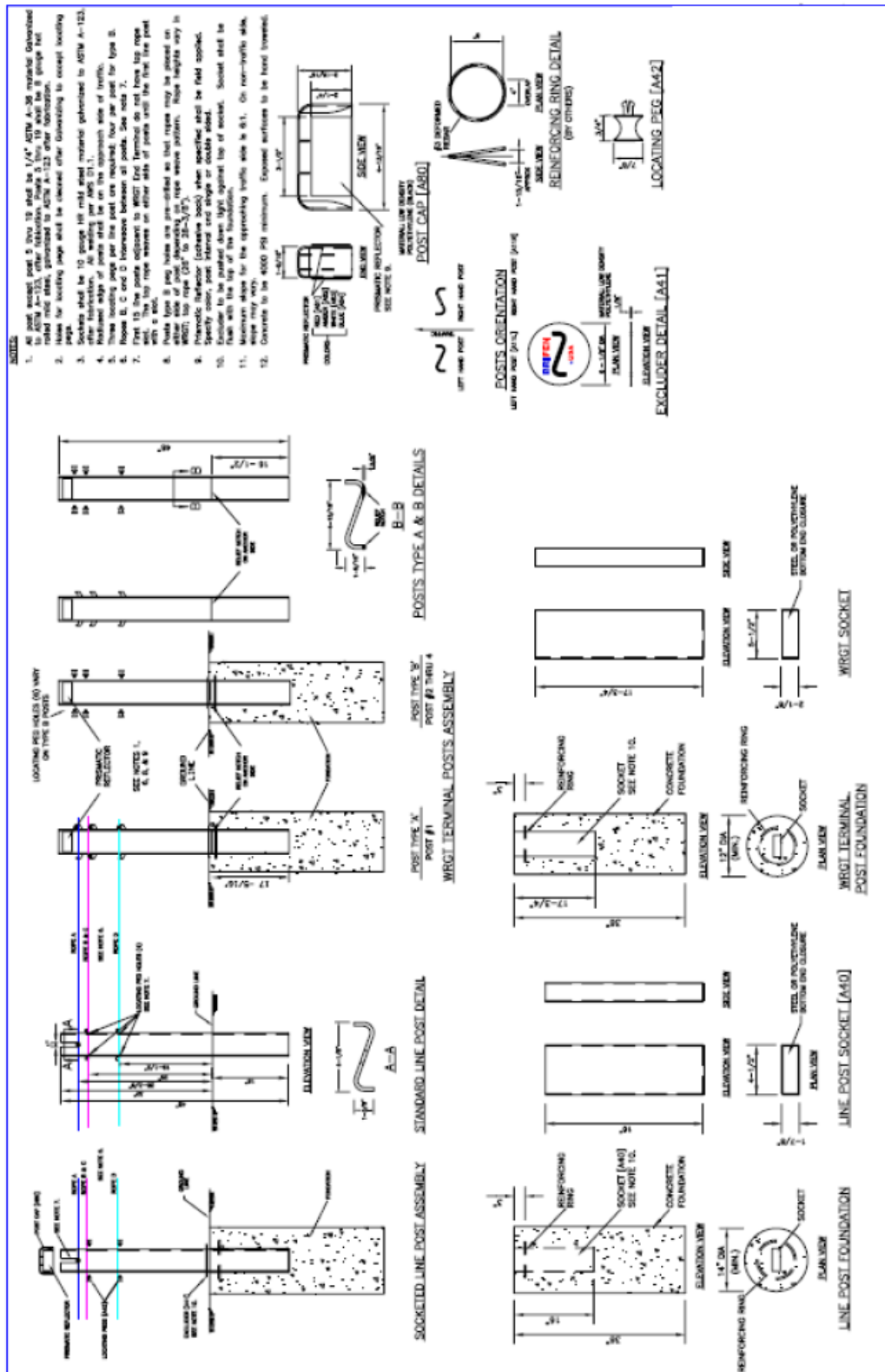




NOTES:

1. Wire rope to be 3/4" (19mm) pre-stretched 3x7 construction meeting ASTM A-741-90 modified to Britten specifications.
2. Minimum breaking load of fitted ropes shall be 36,800 pounds (16.7 Tonne F metric).
3. Threaded terminal and rigging screw galvanized to A153. Threads to be metric 24 X 3 - 7H and develop minimum tensile load of 36,800 pounds (16.7 Tonne F metric) without yielding.
4. When segment lengths permit, right-hand threaded terminal with two (2) nuts may be used at end anchor in lieu of combination mechanical fitting.
5. Combination mechanical fitting shall develop minimum breaking load as Note 2.
6. Rigging screws shall not be tensioned after installation, per Tension Chart below.
7. Wire ropes are to be tensioned after installation, per Tension Chart below.

TENSION CHART			
AMBIENT TEMPERATURE		ROPE TENSION	
C	F	KN	LBS
43	110	8.5	1410
38	100	9.4	2110
35	95	11.25	2531
30	86	14.00	3155
25	77	16.75	3789
20	68	19.50	4397
15	59	22.25	5008
10	50	25.00	5625
5	41	27.75	6244
0	32	30.50	6863
-5	23	33.25	7481
-10	14	36.00	8100
-15	5	40.40	9100





REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 02829

SWING GATE OPERATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for swing gate operators.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 02823 - Ornamental Metal Fences and Gates.
 - 6. Section 04810 - Unit Masonry Assemblies.
 - 7. Section 16061 - Electrical Grounding and Bonding.
 - 8. Section 16120 - Conductors and Cables.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ABS: Acrylonitrile butadiene styrene.
 - 2. AC: Alternating electric current.
 - 3. DC: Direct electrical current.
 - 4. EMI: Electromagnetic interference.
 - 5. LED: Light emitting diode.
- B. Reference Standards:
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. UL 325 – Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.
 - b. UL 991 – Standard for Tests for Safety-Related Controls Employing Solid-State Devices.
 - 3. United States Government:
 - a. Department of Justice:
 - 1) 28 CFR 36 Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - b. Office of the Secretary of Transportation:
 - 1) 49 CFR 37 Transportation Services for Individuals with Disabilities (ADA).
 - c. Parks, Forests, and Public Property:



- 1) 36 CFR 1192 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- d. United States Code (U.S.C.):
 - 1) 42 U.S.C. Section 4151 et seq.
 - a) Architectural Barriers Act, Public Law 90-480.
 - 2) 42 U.S.C. Section 12101 et seq.
 - a) Americans with Disabilities Act (ADA), Public Law 101-336.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the installation of swing door operators with the installation of the gates and fences provided under Section 02823, Ornamental Metal Fences and Gates, the supporting structures provided under Section 04810, Unit Masonry Assemblies, and the power conduit and wiring provided by others.
- B. Sequencing:
 1. Prior to installing the swing gate operator, the gates to be operated and the adjacent surfaces where the gate operators are to be mounted must be completed.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Swing gate operators.
 - b. Shop Drawings:
 - 1) Swing gate operators.
 - c. Certificates:
 - 1) Swing Gate Operator Certificates of Compliance.
 - d. Qualification Statements:
 - 1) Swing gate operator manufacturer's qualifications.
 - 2) Swing gate operator installer's qualifications.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Swing gate operators.



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the swing gate operators.
 - b. Warranty Documentation:
 - 1) Swing Gate Operator Warranty.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Swing Gate Operator Manufacturer's Qualifications:
 - a. Obtain the swing gate operators from a manufacturer that has been regularly engaged for the past 5 years in manufacturing gate operators similar in type to that specified as the Work of this Section.
 - b. Submit the swing gate operator manufacturer's qualifications to the Program/Project Manager for approval.
2. Swing Gate Operator Installer's Qualifications:
 - a. Employ a swing gate operator installer who has been regularly engaged for the past 3 years installing gate operators similar in type to that specified as the Work of this Section.
 - 1) Employ persons specifically trained to install gate operators.
 - b. Submit the swing gate operator installer's qualifications to the Program/Project Manager for approval.

B. Certifications:

1. Swing Gate Operator Certificates of Compliance:
 - a. For swing gate operator materials, submit the manufacturer's Certificates of Compliance, certifying that these items comply with the requirements specified and are suitable for intended application, to the Program/Project Manager for approval.
2. Listing and Labeling:
 - a. Provide swing gate operators and components that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratories, Inc. (UL) in accordance with the requirements specified in UL 325 and UL 991 for the location the product is installed in and the application intended.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver the swing gate operator materials to the Site in the manufacturer's original, unopened containers and packaging, having labels clearly identifying the product by name and manufacturer.
- B. Storage and Handling Requirements:
 - 1. Store and handle the swing gate operator materials in accordance with the manufacturer's instructions.
 - 2. Keep the swing gate operator materials in the manufacturer's original, unopened containers and packaging until installation.
 - 3. Store the swing gate operator materials in a clean, dry area indoors.
 - 4. Protect swing gate operator materials during storage, handling, and installation to prevent damage.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Manufacturer Warranty:
 - 1. Swing Gate Operator Warranty:
 - a. Warrant the swing gate operator materials and workmanship against failures within the 2 year period after the Date of Substantial Completion:
 - b. Submit the written Swing Gate Operator Warranty on the swing gate operator manufacturer's standard form in which the swing gate operator manufacturer agrees to repair or replace components of the swing gate operators that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 SWING GATE OPERATOR EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Performance:
 - 1. Maximum Gate Weight:
 - a. Provide swing gate operators that are capable of operating gates that weigh up to 600 pounds.
 - 2. Maximum Gate Length:
 - a. Provide swing gate operators that are capable of operating gates that are up to 14 feet long.
 - 3. Maximum Aperture Angle:
 - a. Provide swing gate operators that are capable of opening 130 degrees.
 - 4. Operating Speeds:
 - a. Provide swing gate operators having operating speeds of no more than 13 seconds for each 90 degrees of gate movement.
 - 5. Operating Temperatures:
 - a. Provide swing gate operators that are capable of operating gates within a temperature range from minus 4 degrees Fahrenheit (minus 20 degrees Celsius) to 158 degrees Fahrenheit (70 degrees Celsius).
 - 6. Maximum Duty Cycle:
 - a. Provide swing gate operators that have a continuous duty cycle of 100 percent.
- C. Design Criteria:
 - 1. Provide swing gate operators that comply with the requirements for Class I, II, III, and IV vehicular gate operators and systems specified in UL 325.
 - 2. Provide swing gate operator logic boards to have redundancy designed into their hardware and firmware.
 - 3. Provide swing gate operators designed to automatically open the gate in case of a power failure.
 - 4. To protect gate users against entrapment, provide secondary protection devices, such as edge sensors and photo beams.
 - 5. Product Data:
 - a. Obtain the manufacturer's Product Data for the swing gate operators provided under this Section, including the swing gate operator manufacturer's published installation instructions.
 - b. Submit swing gate operator manufacturer's Product Data to the Program/Project Manager for approval.
 - 6. Shop Drawings:
 - a. Prepare Shop Drawings for the swing gate operators, including layout drawings and wiring diagrams.
 - b. Submit the swing gate operator Shop Drawings to the Program/Project Manager for approval.



D. Materials:

1. Swing Gate Operators:

a. Control Enclosure:

- 1) Provide swing gate operators having powder coated, aluminum control board enclosures.

b. Power:

1) Main Power Source:

- a) Provide swing gate operators capable of operating on single phase 120-Volt AC electrical power.
- b) Provide swing gate operators having a built-in power selector switch.

2) Current Consumption:

- a) Provide swing gate operators that consume no more than 3 Amperes at 120 Volts AC.

3) Electromagnetic Interference (EMI) Filter and Lightning Protection:

- a) Provide swing gate operators having an electromagnetic interference (EMI) filter and lightning protection for AC lines up to 6 kilovolts and 3 kiloamperes.

c. Logic Boards:

1) Lightning-Strike Protection:

- a) Provide swing gate operator logic boards having multiple-stage built-in lightning-strike protection for up to 20 kilovolts and 10 kiloamperes.

2) Short Circuit Protection:

- a) Provide swing gate operator logic boards having multiple-stage short circuit protection.

3) Logic Board Power:

- a) Provide swing gate operator logic boards having a regulated power supply for external accessories up to 1 Ampere.
- b) Provide swing gate logic boards having a built-in battery charger.

4) Controls:

a) Travel Controls:

- (1) Provide swing gate operator logic boards having a soft stop/start control.
- (2) Provide swing gate operator logic boards having self-adaptive and self-learn algorithms for controlling travel through the gate.

b) Magnetic Locks:

- (1) Provide swing gate operator logic boards having a 10 Ampere contact with a built-in 24-Volt DC power source for controlling magnetic locks.

c) Obstruction Controls:



- (1) Provide swing gate operator logic boards having multiple algorithms to supervise obstructions detected by an intelligent obstruction sensor, and a hold-open timer.
- 5) Connectors:
 - a) Provide swing gate operator logic boards having pluggable connectors.
- 6) Indicators:
 - a) Provide swing gate operator logic boards having light emitting diode (LED) indicators that indicate the status of external accessories and power.
- 7) Tandem Gates:
 - a) To synchronize the operation between 2 tandem gates, provide swing gate operator logic boards having a master-slave port.
 - b) Overlap Delay:
 - (1) Provide swing gate operator logic boards having an overlap delay adjustable from 0 seconds to 6 seconds to control master-slave operation or tandem gates, and to open 1 gate first and after few seconds open second gate.
- d. Motor/Gear Units:
 - 1) Provide swing gate operators having 1/2 horsepower 24-Volt DC motors.
 - 2) Cable for Motors:
 - a) Provide cable for the motors having the following features:
 - (1) 7 conductors.
 - (2) Direct burial type shielded with a drain wire.
 - (3) Sun resistant.
 - (4) Water resistant.
- e. Motor Gear Head Cover:
 - 1) Provide swing gate operators having acrylonitrile butadiene styrene (ABS) plastic motor gear head covers.
- f. Clutch Mechanism:
 - 1) Provide swing gate operators having a clutch mechanism that allows full and safe operation of the gate operator by using a key.
- g. Manufacturers:
 - 1) Viking Access Systems, Model "X-9",
<http://www.vikingaccess.com>.
 - 2) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the areas and swing gates to receive the swing gate operators.



- a. Verify that the gates are installed as indicated on the Contract Drawings.
 - b. Verify that the gates are properly installed, and that they move freely in both directions.
 - c. Verify that the gates are plumb, level, square, and without sag or damage.
- B. Evaluation and Assessment:
1. Notify the Program/Project manager of conditions that would adversely affect installation or subsequent use of the swing gate operators.
 2. Do not begin installation of the swing gate operators until unacceptable conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect adjacent areas from damage resulting from installation of the swing gate operators.
- B. Demolition/Removal:
1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install the swing gate operators in accordance with swing gate operator manufacturer's instructions at the locations indicated on the Contract Drawings.
1. Install gate operators plumb, level, square, and secure.
 2. Install the swing gate operators so they are weathertight.
- B. Special Techniques:
1. Warning Signs:
 - a. Provide a minimum of 2 warning signs, one on each side of the gate.
- C. Interface with Other Work:
1. Firmly attach the articulated arm assembly to the gate being operated by the swing gate operator.
 2. Mount the electronic control panel on surfaces adjacent to the gate in accordance with swing gate operator manufacturer's instructions and as indicated on the Contract Drawings.
- D. Systems Integration:
1. Electrical Connections:
 - a. Ground the swing gate operators in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.



- b. Connect the wiring to the swing gate operators in accordance with the requirements specified in Section 16120, Conductors and Cables.

3.04 SYSTEM STARTUP

- A. Commissioning:
 - 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, for the pertinent systems Work of this Section.

3.05 ADJUSTING

- A. Adjust the swing gate operators for proper operation in accordance with swing gate operator manufacturer's instructions.
- B. Adjust the swing gate operators to operate smoothly, and to open and close the swing gates properly.

3.06 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Demonstrate the operation of the swing gate operators for the Program/Project Manager to show the gate operators function and operate properly.

3.08 PROTECTION

- A. Protect the installed swing gate operators to ensure that, except for normal weathering, the gate operators will be without damage or deterioration at time of Substantial Completion.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish the manufacturer's operation and maintenance data for the swing gate operators for inclusion in operation and maintenance manuals as specified in Section 01780, Closeout Submittals
 - 2. Furnish detailed information required so the Owner can properly operate and maintain the swing gate operators, including the following information:
 - a. Operation instructions.
 - b. Troubleshooting guide.



- c. Parts list.
- d. Electrical wiring diagrams.
- 3. Submit the operation and maintenance data for the swing gate operators to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First edition.



SECTION 02891

POST-MOUNTED SIGNS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing post-mounted roadside signs at the locations indicated on the Contract Drawings in accordance with the details shown on the Contract Drawings, Standard Drawings, and reference documents.
 - a. Required legends are indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M 268 - Standard Specification for Retroreflective Sheeting for Traffic Control (*same as ASTM D 4956*).
- B. ASTM International (ASTM):
 - 1. ASTM A 1 - Standard Specification for Carbon Steel Tee rails.
 - 2. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 4. ASTM A 449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
 - 5. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts [Metric].
 - 6. ASTM A 572/A 572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - 7. ASTM A 588/A 588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance.
 - 8. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 9. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.



10. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 11. ASTM B 449 - Standard Specification for Chromates on Aluminum.
 12. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 13. ASTM B 766 - Standard Specification for Electrodeposited Coatings of Cadmium.
 14. ASTM D 476 - Standard Classification for Dry Pigmentary Titanium Dioxide Products.
 15. ASTM D 523 - Standard Test Method for Specular Gloss.
 16. ASTM D 4956-04 - Standard Specification for Retroreflective Sheetting for Traffic Control.
 17. ASTM F 844 - Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- C. Arizona Department of Transportation (ADOT):
1. ADOT Arizona Supplement to the 2009 Manual on Uniform Traffic Control Devices.
 2. ADOT Traffic Engineering Manual of Approved Signs (MOAS).
 3. ADOT Standard Drawings –Signing and Marking Standards.
 4. ADOT Standard Specifications for Road and Bridge Construction:
 - a. Section 604 – Steel Structures.
 - b. Section 608 – Sign Panels.
 - c. Section 922 – Utility Concrete for Miscellaneous Construction.
 - d. Section 1006 – Portland Cement Concrete.
- D. City of Phoenix (COP):
1. City of Phoenix Supplement to the Maricopa County Association of Governments Uniform Standard Specifications.
 2. Phoenix Supplemental Standard Details for Public Works,
<https://www.phoenix.gov/streets/reference-material/2015maguniformstd>:
 - a. Detail No. P1023 Street Sign Base, Object Marker, and Delineator.
 3. City of Phoenix Street Transportation Department Design Procedure Manual, <http://phoenix.gov/STREETS/autocadhelp.html>.
- E. International Fasteners Institute (IFI):
1. IFI 114 – Standard for Break Mandrel Blind Rivets.
 2. IFI 135 – Mechanical Testing of Blind Rivets.
- F. Maricopa Association of Governments (MAG):
1. MAG Uniform Standard Details for Public Works Construction.
 - a. Standard Detail 131 – Street Sign Base.
- G. Porcelain Enamel Institute, Inc. (PEI):
1. PEI-101 – Design and Fabrication of Metal of Porcelain Enamel.
 2. PEI-501 – Electrostatic Enamel Powder Application.



3. PEI-502 – Dipping and Flow Coating for Porcelain Enamel.
4. PEI-503 – Wet spraying for Porcelain Enamel.
5. PEI-601 – Drying and Firing.
6. PEI-801 – Alloy, Design and Fabrication Considerations for Porcelain Enamel Aluminum.
7. PEI-802 – Pretreatment of Alloys for Porcelain Enamel Aluminum.
8. PEI-803 – Enamel Preparation, Application and Firing for Porcelain Enamel Aluminum.
9. PEI-804 – Quality Control Procedures for Porcelain Enamel Aluminum.

H. Society of Automotive Engineers (SAE):

1. SAE J429 - Mechanical and Material Requirements for Externally Threaded Fasteners.

I. U. S. Government:

1. Department of Transportation (DOT):
 - a. Federal Highway Administration (FHWA):
 - 1) Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), as revised.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Depending on where the signing operations are to occur and the owner of the Right-of-Way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Street Transportation Department.
 - c. Phoenix Sky Harbor International Airport.
2. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.

B. Sequencing:

1. Include provisions for traffic control during sign installation in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Post-mounted sign materials.



- b. Shop Drawings:
 - 1) Post-mounted signs.
 - 2) Sign panels.
 - 3) Standard punch details for demountable characters.
 - c. Certificates:
 - 1) Certificates of Analysis for breakaway sign post shapes.
 - 2) Certificate of Compliance for perforated sign posts.
 - 3) Certificate of Compliance for U-channel sign posts.
 - 4) Certificate of Compliance for round sign posts.
 - 5) Certificate of Compliance for sign panel materials.
 - 6) Certificate of Compliance for fluorescent orange sheeting.
 - d. Special Procedure Submittals:
 - 1) List of New Signs.
- B. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Demountable Character Sheeting, Ink, Film, and Adhesive Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Depending on where the signs are to be placed and the owner of the right-of-way, coordinate with and obtain the required approvals from the appropriate State and municipal departments, including but not limited to, the following:
 - a. Arizona Department of Transportation (ADOT).
 - b. City of Phoenix Street Transportation Department.
 - c. Phoenix Sky Harbor International Airport.
- B. Certifications:
- 1. Certificates of Analysis:
 - a. Submit Certificates of Analysis providing the material composition and properties for breakaway sign post shapes to the Program/Project Manager for approval.
 - 2. Certificates of Compliance:
 - a. Sign Post Certificates of Compliance:
 - 1) For perforated sign posts, U-channel sign posts, and round sign posts materials, submit Certificates of Compliance certifying that these items comply with the requirements specified to the Program/Project Manager for approval.
 - b. Sign Panel Certificates of Compliance:
 - 1) For sign, channeling device, milepost, object marker, guard rail marker, delineator, and reference marker materials, submit Certificates of Compliance certifying that these items comply with



the requirements specified to the Program/Project Manager for approval.

- a) Identify the retroreflective sheeting type, backing class, make of sheeting, inks, and film.
- c. Fluorescent Orange Sheeting Certificates of Compliance:
 - 1) For fluorescent orange sheeting, submit Certificates of Compliance certifying that the sheeting to be used in fluorescent to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Nest U-channel sign posts for shipment, and fasten them together in a manner so they will not slip.
 - a. Take care to minimize posts rubbing together during shipping which will result in surface damage to the galvanized finished.
 - 1) Excessive damage to the finish of the posts during shipping or handling will result in rejection of the damaged posts.
 - b. Do not bundle U-channel sign posts in groups of more than 100.
- 2. Ship sign panels as recommended by the sign panel manufacturer.
 - a. Ship fabricated flat signs and overlay sheets on edge.
 - b. Rigidly brace shop-fabricated extruded sign panel sub-assemblies for shipping.
 - 1) Bent bolt channels on extruded sign panels are cause to reject the sign panel.
 - c. Damage to sign panels or legends resulting from banding, crating, or stacking may is cause for rejecting the sign.

B. Storage and Handling Requirements:

- 1. Store and handle sign panels as recommended by the sign panel manufacturer.
 - a. Rigidly brace shop-fabricated extruded sign panel sub-assemblies for erection.
- 2. Store fabricated signs indoors, and keep them dry during storage.
 - a. If packaged signs become wet, remove the package materials and allow the signs to dry.
 - b. Repackage the signs using new materials.
 - c. If outdoor storage is necessary, remove the packaging materials.
- 3. Store the signs on edge, aboveground, and in an area where dirt and water will not contact the sign face.
- 4. Do not allow materials used to support stored signs to contact the sign faces.

1.07 WARRANTY

A. Manufacturer Warranties:

- 1. Demountable Character Sheeting, Ink, Film, and Adhesive Warranty:



- a. Provide a manufacturer's warranty for the sheeting, inks, films, and adhesives against the defects listed in the Retroreflective Sheeting Durability Test as specified herein:
 - 1) Provide a manufacturer's warranty for the porcelain-enameled, powder-coated, or laminated opaque acrylic film provided for demountable characters.
- b. Provide a manufacturer's warranty for the sheeting, inks, films, and adhesives for the following periods:
 - 1) Warrant orange sign sheeting, ink, film, and adhesive for 3 years.
 - 2) Warrant Types I, II, III, V, VI, and VII sheeting, ink, film, and adhesive for 5 years.
 - 3) Warrant Types IV, VIII, IX, X, and XI sheeting, ink, film, and adhesive for 10 years.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

A. Breakaway Sign Posts:

1. At the option of the Construction Manager at Risk, provide breakaway sign posts fabricated from structural steel conforming to the requirements of ASTM A 572/A 572M, Grade 50, or ASTM A 588/A 588M.
 - a. Fabricate breakaway sign posts, stub posts, and base plates in accordance with the requirements of Subsection 604-3.02 of the ADOT Standard Specifications for Road and Bridge Construction, except that Shop Drawings will not be required.
2. Provide base plates for the breakaway connections and friction fuse plates and back plates for the post hinge assembly fabricated from the same type of structural steel selected for the sign posts.
 - a. Drill plate holes.
 - b. Drill or sub-punch and ream flange holes.
 - c. Saw cut plate notches, except that flame cutting is permitted provided all edges are ground.
3. Galvanized posts and plates after fabrication in accordance with the requirements of ASTM A 123/A 123M.
4. Hardware:
 - a. Provide bolts, nuts, and washers conforming to the requirements of ASTM A 325.
 - b. Provide bolts, nuts and washers that have either been cadmium plated in accordance with the requirements of ASTM B 766, or zinc plated in accordance with the requirements of ASTM B 633.
5. Saw cut the posts for the hinge, and bolt the post and post hinge assembly together.

B. Perforated Sign Posts (Single and Telescoping):

1. Provide perforated square tube sign posts fabricated so they are straight and have a smooth, uniform finish; and so consecutive telescoping post



sizes freely telescope with one another for not less than 10 feet of their length without the necessity of matching any particular face to any other face.

- a. Fabricate the square tube sign posts from galvanized sheet steel conforming to the requirements of for either SQ Grade 40 or SQ Grade 50 Class 1 as specified in ASTM A 653/A 653M.
 - 1) Sheet Steel Thickness:
 - a) Provide 0.105-inch (12 gauge) or 0.135-inch (10 gauge) thick sheet steel as required by the Contract Documents.
 - 2) Weld the corner of the posts directly using high frequency resistance welding or equivalent means.
 - 3) Scarf the outside edges of the posts as necessary to produce standard corner radii of 5/32 plus or minus 1/32 inch.
 - b. Galvanize the steel in accordance with the requirements of Coating Designation G-90.
 - 1) Re-galvanize external welded surfaces and scarfed areas after fabrication.
 - 2) Posts Wall Thickness Including Coating:
 - a) Provide 0.097-inch to 0.116-inch post walls for 12 gauge sheet steel, and 0.127-inch to 0.146-inch post walls for 10 gauge sheet steel.
2. Perforation Holes:
 - a. Provide 7/16-inch plus or minus 1/64 inch diameter holes on 1-inch centers on all four sides of the posts and along their entire length.
 - 1) Laterally center the holes on the longitudinal centerline of each face.
 - 2) Position and space the holes the same on all four faces, so the hole centerlines for each group of 4 holes pass through a common point on the longitudinal centerline of the tube.
 - 3) For telescoping posts, properly align the holes in each tube to allow 3/8-inch diameter bolts to pass through the entire telescoping post from one side to the other.
 3. Hardware:
 - a. Provide bolts, nuts and washers that have been either zinc coated in accordance with the requirements of ASTM B 633 or cadmium plated in accordance with the requirements of ASTM B 766.
 - b. Bolts:
 - 1) Provide bolts conforming to the requirements of SAE J429, Grade 5, or ASTM A 449, Type 1.
 - c. Nuts:
 - 1) Provide nuts conforming to the requirements of ASTM A 563, Grade A.
 - d. Washers:
 - 1) Provide washers conforming to the requirements of ASTM F 844.

C. U-Channel Sign Posts:



1. Provide U-channel sign posts consisting of a “sign post” and a “base post”, each “post” a uniform, modified, flanged channel-section, as shown in the Contract Drawings.
 - a. Fabricated the U-channel posts from rerolled rail steel or hot-rolled carbon steel bars:
 - 1) Provide rail steel having a minimum yield point of 80,000 pounds per square inch.
 - 2) Provide rail steel having a nominal weight of 91 pounds per yard prior to rerolling.
 - 3) Provide rail steel that complies with the quality assurance requirements of ASTM A 1.
 - 4) Provide rail steel having the cast heat analysis given in Table 02891-1.

Table 02891-1 U-Channel Sign Post Steel Analysis	
Element	Composition (Percent)
Carbon	0.67 – 0.82
Manganese	0.70 – 1.01
Phosphorous	0.04 maximum
Sulfur	0.05 maximum
Silicon	0.10 – 0.25

- b. Galvanize the U-channel sign posts after fabrication in accordance with the requirements of ASTM A 123/A 123M.
 - c. Post Weight:
 - 1) Provide posts weighing 3 pounds per lineal foot, plus or minus 5 percent.
2. Post Lengths:
 - a. Furnish “sign posts” in 6-inch increments of length up to 12 feet as required for the installation location.
 - b. Furnish 42-inch long “base posts” that are pointed at one end.
3. Perforation Holes:
 - a. Provide “sign posts” having 3/8-inch diameter holes punched continuously along the post on 1-inch centers.
 - 1) Locate the first and last holes 1 inch from the top and bottom of post.
 - b. Provide “base posts” having at least eighteen holes starting 1 inch from the top and continuing at one-inch increments along the post.
4. Hardware:
 - a. Provide bolts, nuts, washers, and spacers that have been either zinc coated in accordance with the requirements of ASTM B 633 or cadmium plated in accordance with the requirements of ASTM B 766.



D. Round Sign Posts:

1. Provide round sign posts fabricated from galvanized steel.
 - a. Outside Diameter: 2-7/8 inches.
 - b. Steel Thickness:
 - 1) Provide 0.105-inch (12 gauge) or 0.135-inch (10 gauge) thick steel as required by the Contract Documents.
1. Hardware:
 - a. Provide bolts, nuts and washers that have been either zinc coated in accordance with the requirements of ASTM B 633 or cadmium plated in accordance with the requirements of ASTM B 766.
 - b. Bolts:
 - 1) Provide bolts conforming to the requirements of SAE J429, Grade 5, or ASTM A 449, Type 1.
 - c. Nuts:
 - 1) Provide nuts conforming to the requirements of ASTM A 563, Grade A.
 - d. Washers:
 - 1) Provide washers conforming to the requirements of ASTM F 844.

E. Foundation Stub Posts:

1. Fabricated foundation stub posts from the same type of steel selected for the appropriate sign posts.

F. Flat Sign Panels:

1. Provide flat sign panels fabricated in one piece from flat sheet aluminum panels with direct applied or silk-screened characters.

G. Extruded Sign Panels:

1. Provide extruded sign panels fabricated from Aluminum Alloy 6063-T6 complying with the requirements specified in ASTM B 221, and consisting 12-inch wide aluminum extrusions having an aluminum side trim molding fastened to each with two 5/32-inch diameter self-plugging blind shoulder rivets located 2-1/2 inches from either edge.
 - a. Cover the panel facing with retroreflective sheeting of the color indicated on the Contract Drawings.
2. Provide aluminum extrusions flat within a tolerance of 1/4 inch in 8 feet, allowing proportionately greater tolerances on lengths greater than 8 feet.
 - a. The flatness tolerance across the face of each extrusion is 0.5 percent of the width.
3. Fasten the aluminum extrusions together using bolted connections as indicated on the Contract Drawings.
 - a. Bolt the aluminum extrusions together on 12-inch centers.
 - b. The allowable gap between extrusions is 1/32 inch.
4. Provide demountable characters for the extruded sign panels, including letters, numerals, symbols, borders, and other features of the sign message.



- a. Provide mounting holes within the frames for screws, rivets, or other common fasteners.
 - b. For framed demountable characters, provide 5/32-inch diameter self-plugging blind shoulder rivets set tight and at least 3/4 inch long to extend through the panel face.
 - 1) Size and space white reflectors so the legibility and visibility of the finished cut-out character is maximized.
 - 2) For black frames, provide black anodized self-plugging aluminum blind shoulder rivets or round head screws
 - c. For sheet aluminum demountable characters, provide 5/32-inch diameter self-plugging blind shoulder rivets set tight and at least 5/8 inch long to extend through the panel face.
5. Provide hardware for fastening the extruded sign panels to supports as recommended by the panel manufacturer.
 - a. Provide sufficient bolt clamps placed to install the sign panels on the sign posts as indicated on the Contract Drawings.

2.02 DESIGN CRITERIA

- A. If the signs are in Arizona Department of Transportation (ADOT) Right-of-Way, comply with signage requirements of the following documents:
 1. FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).
 2. ADOT Arizona Supplement to the 2009 Manual on Uniform Traffic Control Devices.
 3. ADOT Manual of Approved Signs (MOAS).
 4. ADOT Standard Drawings –Signing and Marking Standards.
 5. ADOT Standard Specifications for Road and Bridge Construction:
- B. If the signs are in City of Phoenix or Phoenix Sky Harbor International Airport Right-of-Way, comply with applicable requirements of this Section.
- C. Submit Product Data for the sign materials and Shop Drawings for the signs provided under this Section to the Program/Project Manager for approval.
 1. List of New Signs:
 - a. Prepare a detailed list of the new signs installed under this Contract in a commonly used electronic spreadsheet format, such as Microsoft Excel®.
 - 1) Include the sign identification code; the date each sign was installed including the month and year; the sign's fabricator; and information regarding the materials including the material manufacturer, and type of sheeting, ink, and film.
 - 2) List the signs in numerical order by route, direction, and milepost; and if more than 1 sign is installed in the same general location, include a letter subscript.
 2. Submit the List of New Signs to the Program/Project Manager for approval.



2.03 MATERIALS:

A. Flat Sheet Aluminum:

1. For flat sheet signs, provide 0.125-inch thick flat aluminum sheet made of 5052-H38 aluminum alloy conforming to the requirements of ASTM B 209.
2. For demountable characters, provide flat aluminum sheet made of 3105-H14, 3003-H14, or 5052 aluminum alloy conforming to the requirements of ASTM B 209.
 - a. For letters and numbers, provide 0.032 inch thick sheets.
 - b. For symbols, route shields, and borders, provide 0.063 inch thick sheets.
 - c. Chemically treat the aluminum with a chromate acid conversion type coating, or equivalent, to form an oxidation-resistant barrier film suitable for long term outdoor use.
 - 1) Provide a coating that prevents oxidation responsible for causing streaking or discoloration on the sign.
 - 2) Apply a minimum 0.002-inch thick coating according to the manufacturer's instructions.

B. Concrete:

1. For Breakaway Sign Post Foundations:
 - a. Provide Class B concrete conforming to the requirements of Section 1006 of the ADOT Standard Specifications for Road and Bridge Construction.
 - b. For foundations using stub post sizes S 3 X 5.7 and S 4 X 7.7, utility concrete conforming to the requirements of Section 922 of the ADOT Standard Specifications for Road and Bridge Construction
2. For Perforated Sign Post and U-Channel Sign Post Foundations:
 - a. Provide concrete, when required, conforming to the requirements of Subsections 922-2 and 922-3 of the ADOT Standard Specifications for Road and Bridge Construction.
3. For Breakaway Sign Post Foundations:
 - a. Provide Class C concrete conforming to the requirements specified in Section 03300, Cast-In-Place Concrete.

C. Retroreflective Sheeting:

1. Retroreflective Sheeting Types and Classes:
 - a. For each application, provide the Type and Class of retroreflective sheeting indicated on the Contract Drawings.
 - b. Provide retroreflective sheeting complying with the criteria for the applicable Type and Class as specified in ASTM D 4956-04, for the applicable type and class unless otherwise specified.
 - 1) For all signs used for a particular application under this Contract, provide materials of the same ASTM material, manufacturer, and product type.
 - a) For letter and number text, provide sheeting of the same type and brand.



- 2) For applications where more than one type of sheeting is allowed, a higher grade of sheeting than indicated may be provided if at no increase in Contract Price.
 - 3) Provide a retroreflective sheeting system having a smooth outer surface and, except for self-supporting products having a Class 5 backing such as roll-up signs and some types of traffic cone collars, a pre-coated adhesive on the back side protected by an easily removable liner.
 2. Opaque Films:
 - a. Provide acrylic type opaque films for use with the sheeting.
 3. Adhesive System:
 - a. Provide either Class I or Class II adhesives complying with the requirements specified in ASTM D 4956, and that under all weather conditions form a tight and durable weatherproof bond to the sign background capable of enduring for the required durability time for the material.
 - 1) Provide an adhesive system that remains bonded to its surface without discoloring, cracking, crazing, peeling, blistering, or changing dimension or alignment.
 - b. Pressure Sensitive Adhesives:
 - 1) Provide aggressive tack type pressure sensitive adhesives that require no heat, solvent, or other pre-application preparation of sheeting or film for its adhesion to clean aluminum, plywood, or reflective sheeting surfaces.
 - 2) Pre-treat plastic surfaces as recommended by the sheeting manufacturer.
 - c. Heat-Activated Adhesives:
 - 1) Provide heat-activated adhesives capable of being positioned under normal working conditions and temperatures without damaging the materials or application surfaces, and that are activated by applying heat in excess of 150 degrees Fahrenheit to the material using a heat vacuum process.
 - 2) Provide heat-activated adhesives that do not require pre-treatment of the adhesive.
 4. Coefficient of Retroreflection:
 - a. Provide retroreflective sheeting having a coefficient of retroreflection complying with the requirements specified in ASTM D 4956 for the type of retroreflective sheeting specified.
 - b. For black films, provide film having a maximum coefficient of retroreflection of 1.0 at an observation angle of 0.2 degrees and an entrance angle of negative 4.0 degrees.
 - 1) For direct-applied and demountable black characters, provide non-reflective material.
 5. Color:
 - a. Provide retroreflective sheeting having the color required by the appropriate signage standard for the location and application.



- 1) Except as otherwise specified, provide sheeting, ink, and film colors complying with the requirements specified in the ADOT Traffic Engineering Manual of Approved Signs (MOAS), Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices, and the Contract Drawings.
 - 2) For warning signs with yellow backgrounds, provide fluorescent yellow sheeting.
 - 3) For work zone signs with orange backgrounds, provide fluorescent orange sheeting.
 - a) For temporary work zone signs clearly visible under available light, non-reflective materials may be furnished.
 - b. Provide uniformly colored sheeting, inks, and film so no visual variation in appearance on the same sign or from sign to sign of the same color is apparent.
 - c. Where standard colors are specified for sheeting, inks, and films, provide colors that visually match the color standard and are within the color tolerance limits required by the FHWA Highway Tolerance Charts.
 - d. Unless otherwise indicated, provide sheeting having Luminance Factor (Daytime Luminance) and Color Specification Limits (Daytime) complying with the requirements specified in ASTM D 4956.
 - 1) For fluorescent orange sheeting, provide sheeting having the capacity to effectively fluoresce outdoors under low light conditions.
6. Color Processing:
- a. For both transparent and opaque inks used for post-screen or pre-screen printing of signs, provide a type and quality specified by the sheeting manufacturer, and complying with the requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), the ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices, and the Federal Highway Administration for highway signs.
 - 1) Apply inks using equipment and in the manner recommended by the ink manufacturer.
 - 2) Ensure that the signs produced have a uniform legend of consistent stroke width and sharply defined edges without blemishes that negatively impact appearance, color, or required reflectivity.
7. Specific Intensity Per Unit Area (SIA):
- a. Provide retroreflective sheeting having at least the minimum Specific Intensity Per Unit Area (SIA) requirements of ASTM D 4956 for the type of sheeting provided.

D. Hardware and Fasteners:

1. Blind Rivets:



- a. Provide self-plugging, protruding, regular head blind rivets, complying with the requirements specified for either Grade 10 or 11 aluminum alloy break mandrel blind rivets in IFI 114.
- b. Provide rivets having ultimate shear and tensile strengths that meet or exceed the values specified in Table 6 of IFI 114 for a Grade 10 or 11 rivet having a nominal rivet diameter of 5/32 (0.1562) inch when tested in accordance with the requirements specified in Specifications 2.1 and 2.2 in IFI 135.
 - 1) Rivets having higher strengths or grades than specified herein may be substituted for the rivets specified.
- c. Color:
 - 1) Color the protruding head and shaft of the rivets to closely match the color of the character on which they are being applied, except aluminum colored rivets may be used to mount white characters
 - 2) Provide a factory-applied anodized type finish, or equivalent coating, suitable for long term outdoor applications to color the rivets.
 - a) Provide durable colorfast coatings capable of preventing oxidation that may cause streaking or discoloration of the sign.
 - b) Non-factory painting of the rivets' protruding heads is unacceptable.

2.04 SHOP FABRICATION:

A. Sign Panel Fabrication:

1. Fabricate the sign panels in accordance with the details on the Contract Drawings and the requirements herein.
 - a. If additional details are required, prepare Shop Drawings for the sign panels, and submit them to the Program/Project Manager for approval.
2. Cut panels to size and shape and free of buckles, warps, dents, cockles, burrs, and other defects resulting from fabrication.

B. Flat Sign Panel Fabrication:

1. Fabricate sign panels in one piece from flat sheet aluminum.
2. To reduce glare from reflected sunlight, etch the surfaces of the sign panels not to be covered
3. Prepare and cover the sign panel facing with retroreflective sheeting.
4. Provide sign messages either by silk screening or direct-applying the lettering indicated on the Contract Drawings and shown in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices, ADOT Traffic Signing and Marking Standard Drawings, and/or ADOT Traffic Engineering Manual of Approved Signs (MOAS) as applicable.



C. Extruded Sign Panel Fabrication:

1. To reduce glare from reflected sunlight, etch the exposed surfaces of the side trim molding on the sign panels in accordance with the extrusion manufacturer's recommendations.
2. After the sign structure has been fabricated, including cutting and punching all holes required except those holes for demountable letters, numerals, symbols, and borders, degrease the structure and apply retroreflective sheeting.
3. Prepare and cover the sign panel facing with retroreflective sheeting.
4. Provide sign messages either by silk screening or direct-applying the lettering as indicated on the Contract Drawings and shown in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices, ADOT Traffic Signing and Marking Standard Drawings, and/or ADOT Traffic Engineering Manual of Approved Signs (MOAS) as applicable.

D. Applying Retroreflective Sheeting:

1. Apply sheeting, inks, and, if required, clear coats, in accordance with the manufacturer's instructions; and so no bubbles, wrinkles, or foreign material are beneath the sheeting, ink, or film.
 - a. Do not splice retroreflective sheeting on sign panels having a minimum dimension up to and including 4 feet.
 - b. Provide retroreflective sheeting of the color indicated on the Contract Drawings or shown in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), ADOT Arizona Supplement to the 2003 Manual on Uniform Traffic Control Devices, ADOT Traffic Signing and Marking Standard Drawings, and/or ADOT Traffic Engineering Manual of Approved Signs (MOAS) as applicable.
2. Install retroreflective sheeting so it has a zero-degree orientation.

E. Silk Screened Lettering:

1. Apply silk-screened letters, numerals, arrows, symbols, and borders on the retroreflective background of the sign by direct or reverse screen processes.
 - a. Apply messages and borders of a color darker than the background using the direct process.
 - b. Apply messages and borders of a color lighter than the background using the reverse screen process.
2. Provide opaque or transparent colors, inks, and paints to fabricate signs of the type and quality recommended by the reflective sheeting manufacturer.
3. Apply inks and paints using a screen process resulting in a uniform color and tone, and producing sharply defined legend and border edges without blemishes on the sign background that affect the intended use.



- a. After the ink has been applied, the inked colors must comply with the minimum Specific Intensity Per Unit Area (SIA) requirements for the basic color and the type of sheeting used.
 4. After screening, air-dry or bake the signs in accordance with the manufacturer's recommendations to provide a smooth hard finish.
 - a. Signs on which blisters appear during the drying process are unacceptable.
- F. Direct-Applied Lettering:
 1. Cut direct-applied letters, numerals, arrows, symbols, borders, and other features of the message from black opaque or retroreflective sheeting of the color specified, and apply these characters to the retroreflective sheeting of the sign background in accordance with the instructions of the retroreflective sheeting manufacturer by heat activating the sheeting's adhesive.
 2. The retroreflective sheeting used for the characters must comply with the minimum Specific Intensity Per Unit Area (SIA) requirements of the background sheeting.
- G. Demountable Character Fabrication:
 1. Sign Messages:
 - a. Provide sign messages consisting of letters, numerals, symbols, route shields, borders, and other features that are cut out of flat sheet aluminum having direct-applied sign sheeting or other finishes, and riveted to the sign panel.
 - b. Place the characters on the sign panel in a straight and true fashion.
 - c. Provide characters that fit flat on the sign panel face with no visible gap or deformation.
 2. Characters and Borders:
 - a. Provide letters and numbers as indicated in the Contract Documents.
 - 1) Fabricate character corners and edges to be clean and well-defined without apparent waviness, tears, delamination, deformation, or flaws.
 - 2) Remove burrs and waste material so the characters have a clean, flat, and correct appearance.
 - b. Unless otherwise indicated, fabricate the borders on signs having demountable characters from aluminum substrate panels.
 - 1) Always fabricate the borders from the same material as the sign legend.
 3. Splices:
 - a. Aluminum Panels:
 - 1) Aluminum panel splices are acceptable only for diagrammatic arrows or other large symbols and shields exceeding 48 inches in more than one direction.
 - a) Provide a continuous, 4-inch to 6-inch wide aluminum back plate that overlaps the splice joint, and prevents a formation of



a gap at the splice joint when the symbol is assembled and attached to the sign.

b. Sheeting:

- 1) Provide sheeting or applied film for demountable characters consisting of a continuous monolithic piece without splices or patches covering the entire front face of the character.
 - a) Sheeting splices are permitted only for demountable characters or borders that have a dimension larger than 48 inches in more than one direction.
 - (1) Only 1 splice for every 4 feet is permitted.
 - (2) Where splices are permitted, abut adjoining edges to prevent visible gaps.

c. Colors:

- 1) Demountable Sign Legends:
 - a) For green, blue, and brown background signs, provide white demountable letters, numbers, symbols, and route shields complying with the requirements specified in Paragraph 2.03.G.
 - b) For white and yellow background signs, provide opaque and non-reflective black demountable legends.
 - (1) Acceptable finishes for black characters include porcelain-enameled black, powder-coated black, or laminated black opaque acrylic film applied in accordance with manufacturer's recommendations.
- 2) Demountable Sign Borders:
 - a) For green, blue, or brown sign backgrounds, provide white borders complying with the requirements specified in Paragraph 2.03.G.
 - b) For white or yellow sign backgrounds, provide black borders.
 - (1) Acceptable finishes for black borders include porcelain-enameled black, powder-coated black, or laminated black opaque acrylic film applied in accordance with manufacturer's recommendations.
- 3) For combination signs having differing colored panels, such as a sign having one portion with a green background and white characters and another portion with a yellow background and black characters, provide the border color schemes described in Subparagraph 2.04.G.3.c.1.a or Subparagraph 2.04.G.3.c.1.b for each portion of the sign.

d. Attachment:

- 1) Secure demountable characters to sign panels with 5/32 inch diameter blind rivets of sufficient length to ensure a secure attachment, and complying with the appropriate grip length requirements of the manufacturer.
 - a) When determining the grip length of the rivet, include the total thickness of the joint, including the sheeting and aluminum of



- the character, the spacer if applicable, and the sheeting and aluminum extrusion of the sign back panel.
- 2) Size the holes for installing the rivets in accordance with the recommendations or the rivet manufacturer and Table 2 in IFI 114.
 - 3) Insure that a minimum distance of 4 times the diameter of the rivet exists between the outside of the rivet head and the edge of the character being attached.
 - 4) Place rivets in a defined, evenly spaced pattern which is consistent from character to character, and does not interfere with the appearance of the sign from normal drive-by viewing distance.
 - 5) Attach demountable characters in accordance with the following minimum requirements:
 - a) For straight numerals and letters, provide 3 rivets each including 1 at the top, 1 in the middle and 1 at the bottom.
 - b) For more complex numerals and letters, provide from 4 to 7 rivets each.
 - (1) Letters such as "W" and "M" typically require 7 rivets each.
 - (2) Letters and numerals such as "P", "H", and "9" typically require 6 rivets each.
 - (3) Letters and numerals such as "G", "S", "2", "3", and "7" typically require 5 rivets each.
 - c) For letters or numerals, provide rivets to secure each corner.
 - d) For shields and symbols, space rivets evenly around the entire perimeter, and provide additional rivets in the middle of the shield or symbol as necessary to eliminate bowing.
 - e) For borders, space rivets evenly around each border.
 - 6) The actual number of rivets required depends on the thickness, configuration, weight, position with or without spacers, the size of the character being attached, and the recommendations of the rivet manufacturer.
 - a) Provide a sufficient number of rivets to secure the character to the panel so it does not become misaligned, bend, or move when subjected to wind loading.
 - b) Provide a sufficient number of rivets to ensure that the character does not bow or pull away from the back panel for the life of the sign.
 - 7) Prior to fabricating demountable characters, submit standard punch details for the demountable characters to the Program/Project Manager for approval.

2.05 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Retroreflective Sheeting Durability Test:
 - a. ADOT Approved Products List:



- 1) Sheeting products preapproved by being listed on the ADOT Approved Products List will be accepted without further testing; other products must be subjected to the accelerated Retroreflective Sheeting Durability Test procedure specified herein.
 - a) The test method is considered to produce a 2 to 1 time-acceleration ratio for equivalent vertical exposure.
- b. Test Procedure:
 - 1) Install sheeting products in a south-facing orientation, and subject them to an outdoor desert environment for the following durations:
 - a) Test Types I, II, III, V, VI, and VII sheeting for 30 months.
 - b) Test Types IV, VIII, IX, X, and XI sheeting for 60 months, except test orange sheeting used for construction zone signing, barricades, and channeling devices for 18 months.
 - c) Test each ink and film to the same durability requirements as the related sheeting.
 - 2) Examine the sheeting, ink, film, and adhesive for the following defects, and record the results:
 - a) Bubbles, wrinkles, cracks, or breaks on any portion of the applied materials greater than 3 inches in length that result in a negative appearance or concerns of degradation.
 - b) Significant shrinkage causing material to curl or to pull away from the background.
 - c) Significant delaminating of any material or layer, whether sheeting to substrate, sheeting to sheeting, sheeting to film, ink to sheeting, film to sheeting, or film to film.
 - d) Significant visible discoloration, including clouding or chalking.
 - e) A loss of transparency of any transparent sheeting, ink, or film.
 - f) A loss in opaqueness of any opaque ink or film.
 - g) Significant cracking, blistering, ripping, flaking, curling, or chipping of any sheeting, ink, or film.
 - h) A loss of nighttime retroreflectivity as observed at night under normal conditions, or as defined and measured with a portable retroreflectometer at an observation angle of 0.2 degrees and entrance angle of -4.0 degrees.
 - (1) The measured coefficient of retroreflection must be consistent with what would be expected of the type of material being measured, normal manufacturing variations, the time that the material has been in the field, and FHWA requirements.
 - 3) The durability rating of each product is calculated by multiplying by 2 the testing period during which the material does not exhibit significant degradation, reduced performance, and the defects listed.
- c. Acceptance Criteria:



- 1) Sheeting, ink, film, and adhesive that after the specified test period ends do not exhibit significant degradation, reduced performance, and the defects listed will be acceptable:
 - a) Orange sign sheeting, ink, film, and adhesive achieving a durability rating of 3 years will be acceptable.
 - b) Types I, II, III, V, VI, and VII sheeting, ink, film, and adhesive achieving a durability rating of 5 years will be acceptable.
 - c) Types IV, VIII, IX, X, and XI sheeting, ink, film, and adhesive achieving a durability rating of 10 years will be acceptable.
- B. Non-Conforming Work:
 1. Do not provide sheeting, ink, film, and adhesive products not passing the Retroreflective Sheeting Durability Test.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. At the time construction staking is performed, the Program/Project Manager will determine the required lengths for breakaway sign posts.
 - a. The Program/Project Manager will furnish the required lengths to the Construction Manager at Risk so the Construction Manager at Risk can then order fabrication of the sign posts.
 2. At the time construction staking is performed, the Construction Manager at Risk must determine the lengths required for perforated, U-channel, and round sign posts.
 - a. Cut perforated, U-channel, and round sign posts to length in the field.
 - b. Splicing single perforated posts is not permitted.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Existing signs not shown on the Contract Drawings that do not need to be removed are to remain.
- B. Surface Preparation:
 1. Excavate as required to erect the sign posts in accordance with the requirements of Subsection 203-5.03(A) of the ADOT Standard Specifications for Road and Bridge Construction.
- C. Demolition/Removal:
 1. If signs need to be moved due to construction activities, place the signs as directed by the Program/Project Manager to be as near as possible to their previous location until new signs are installed.



3.03 INSTALLATION

A. Sign Posts:

1. Install the sign posts plumb, and bolted to the foundation stub or base posts, at the locations indicated on the Contract Drawings.
 - a. Affix the sign panels to the posts oriented in the proper direction using the specified hardware.
2. Breakaway Sign Posts:
 - a. Assemble the breakaway sign posts as detailed in the applicable ADOT Standard Drawings.
3. Perforated Sign Posts (Single and Telescoping):
 - a. Construct the foundations for perforated sign posts in accordance with the details and dimensions shown on the Contract Drawings.
 - 1) Place concrete in accordance with the requirements of Section 922 of the ADOT Standard Specifications for Road and Bridge Construction.
4. U-Channel Sign Posts:
 - a. Construct the foundations for U-channel sign posts in accordance with the details and dimensions shown on the Contract Drawings.
 - b. Drive U-channel base posts to a depth of 38 inches into the ground.
 - 1) Where rock is encountered, core, drill, or remove the rock around the post to a minimum diameter of 8 inches and a depth 2 inches below the bottom of the base post
 - a) Solid rock coring and drilling is not required beyond 24 inches in depth regardless of the depth at which the rock is encountered.
 - b) Place Portland cement concrete into the hole in accordance with the requirements of Section 922 of the ADOT Standard Specifications for Road and Bridge Construction, filling it to within 1 inch of the top.
 - c) The base post may be cut at the bottom prior to being set in Portland cement concrete where rock does not permit use of full length base post.
5. Round Sign Posts:
 - a. Construct the foundations for round sign posts in accordance with Detail No. P1023 of the Phoenix Supplemental Standard Details for Public Works.

B. Sign Panels:

1. Install sign panels on overhead sign structures and roadside sign supports in accordance with the details shown on the Contract Drawings and the recommendations of the manufacturers of the sign panel components.
 - a. To prevent damage to the sheeting surface, tighten bolts from the back of the sign by holding the bolt head stationary on the face of the panel.
 - 1) Twisting the bolt head on the panel face is unacceptable.



2. Place signs at the same orientation along the roadway so the entire legend of each sign appears uniform under normal viewing conditions, both day and night.
3. Anodize or paint the heads of bolts on the panel face to match the background color or legend in which they are placed.
4. If the nylon washers on the panel face do not match the background or legend color in which they are placed, paint the washers to match the background or legend color.
5. Using 1-inch high black lettering made from a long life material, such as opaque acrylic film, on the back of each sign, place the sign identification code, the sign fabricator's identification information, the manufacturer of the sheeting used, and the month and year of installation.
 - a. Format the required information as indicated on the Contract Drawings.
 - b. Position the information to be readily visible from a vantage point outside the flow of traffic, and not obstructed by sign posts, extrusions, stringers, or brackets.
 - c. Unless indicated otherwise on the Contract Drawings, construction signs are exempt from the installation information requirement.
 - d. The use of felt markers for this purpose is unacceptable.
6. Where indicated on the Contract Drawings, relocate exit panels to the correct side of the parent sign panel; remove, cut, and install side trim and new or salvaged aluminum extrusions on existing sign panels; relocate large guide and exit gore signs; and cut post tops on existing installations.

3.04 REPAIR/RESTORATION

- A. Minor scratches and abrasions on sign panels resulting from fabrication, shipping, and installation may be patched, but patching is limited to 1 patch for each 50 square feet of sign area and to a total patched area less than 5 percent of the sign area.
 1. Panels requiring more patching than the specified limit are unacceptable.
 2. Seal the edges of patches using a method approved by the retroreflective sheeting manufacturer.

3.05 SITE QUALITY CONTROL

- A. Inspections:
 1. The Program/Project Manager will inspect completely installed sign panels during both daytime and at night for proper appearance, visibility, color, specular gloss, and proper installation.
- B. Non-Conforming Work
 1. Correct apparent sign panel defects disclosed by the Program/Project Manager's inspection at no increase in Contract Price.



- a. If color variations or blemishes between sign panel increments are visible from a distance of 50 feet either during the day or at night, remove the defective panels and replace them with new panels.

3.06 CLEANING

- A. Just prior to inspection of the signs by the Program/Project Manager, thoroughly clean the sign panel faces using a method recommended by the manufacturer.
 1. Furnish cleaning solvent and cleaning materials that do not scratch, deface, or cause adverse effects on the sign panel components.

3.07 PROTECTION

- A. Preserve all roadway signs and sign supports, and replace new roadway signs and sign supports damaged as a result of construction at no increase in Contract Price.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition





SECTION 02892

STRUCTURE MOUNTED SIGNS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for overhead sign structures, including the following types:
 - a. Bridge truss.
 - b. Cantilever truss.
 - c. Tubular overhead.
 - d. Tubular cantilever.
 - e. Bridge tapered tube single beam.
 - f. Cantilever tapered tube double arm.
 - g. Sign attachment structures for existing bridges.

B. Products Supplied But Not Installed Under This Section:

1. Sign Panels:
 - a. Furnish sign panels complying with the requirements for sign panels specified in Section 02891, Post-Mounted Signs, for the structures provided under this Section.
 - b. Install the sign panels under Section 02891, Post-Mounted Signs, as specified therein.

C. Related Requirements:

1. Section 01316 - Project Meetings.
2. Section 01330 - Submittal Procedures.
3. Section 01780 - Closeout Submittals.
4. Section 02473 - Drilled Concrete Shafts.
5. Section 02891 - Post Mounted Signs.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. ANSI: An acronym for the American National Standards Institute.
2. CVN: Charpy V-notch.

B. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO LRFD Bridge Design Specifications.



- b. AASHTO Standard Specifications for Highway Bridges.
- 2. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code-Steel.
 - b. AWS D1.5/D1.5M – Bridge Welding Code.
- 3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 53/A 53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM A 82/A 82M – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - d. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - e. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - f. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - g. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - h. ASTM A 514/A 514M - Standard Specification for High-Yield strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
 - i. ASTM A 572/A 572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - j. ASTM A 588/A 588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance.
 - k. ASTM A 595/A 595M - Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use.
 - l. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - m. ASTM A 673/A 673M - Standard Specification for Sampling Procedure for Impact Testing of Structural Steel.
 - n. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - o. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - p. ASTM B 766 - Standard Specification for Electrodeposited Coatings of Cadmium.
 - q. ASTM E 23 – Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.
- 4. City of Phoenix (COP):



- a. Phoenix Building Construction Code and Amendments.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 6. State of Arizona:
 - a. Arizona Department of Transportation (ADOT):
 - 1) Arizona Test Method 314 – Portland Cement Concrete.
 - 2) ADOT Standard Drawings – Traffic Signing and Marking.
 - 3) ADOT Standard Specifications for Road and Bridge Construction.
- 7. United States Government:
 - a. U.S. Army Corps of Engineers (COE):
 - 1) COE Handbook for Concrete and Cement (Standards).
 - a) COE CRD-C 621 – Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink) (ASTM C 1107-91a).
- 8. Institute for Sustainable Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Attend the pre-installation meeting at the Site held in compliance with the requirements of Section 01316, Project Meetings, to discuss the requirements for constructing the drilled concrete shafts under this Contract.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Nonshrink grout.
 - b. Shop Drawings:
 - 1) Sign structures.
 - c. Certificates:
 - 1) Certificates of Analysis for Structural Steel.
 - d. Delegated Design Submittals:
 - 1) Structural analysis data.
 - e. Qualification Statements:
 - 1) Welding Certificates.
 - 2) Steel Fabricator Qualifications.



- 3) Steel Erector Qualifications.
- 4) Professional Engineer's credentials.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Mill test reports for structural steel shapes, plates, and bars.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's recommendations for mixing, handling, and placing grout.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Sustainable Design Closeout Documentation:
 - 1) Written affidavits from the steel manufacturer verifying that the recycled steel content provided complies with the specified requirements.
 - 2) ENVISION Credit RA 1.3 Use Recycled Materials.
 - 3) ENVISION Credit RA 1.4 Use Regional Materials.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Authority Having Jurisdiction:
 - a. Required approvals depend on who owns the right-of- way and where the structure mounted signs are to be constructed, but must be obtained before construction activities begin from the appropriate State and municipal departments, which may include but are not limited to, the following:
 - 1) Arizona Department of Transportation (ADOT).
 - 2) City of Phoenix Streets Department.
 - 3) Phoenix Sky Harbor International Airport Design and Construction Services.
 - b. If the owner of the right-of- way is other than the Phoenix Sky Harbor International Airport, the owner of the right-of- way will be provided on the Contract Drawings.
2. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Welding Qualifications:
 - a. Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.
 - 1) For all procedures, other than those set forth in AWS D1.1/D1.1M and AWS D1.5/D1.5M, submit a copy of the welding procedure qualification test records.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M and AWS D1.5/D1.5M for the procedures.
 - 1) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
 - 2. Fabricator Qualifications:



- a. Employ a structural steel fabricator experienced in fabricating structural steel similar to that indicated for this Contract.
 - 1) The fabricator chosen must participate in the AISC Quality Certification Program, and must have the AISC "Certification Standard for Steel Building Structures".
 - 2) Use a structural steel fabricator exhibiting a minimum of 5 continuous years of successful in-service performance.
 - b. Employ a structural steel fabricator having sufficient production capacity to produce and deliver the materials in time to meet the approved construction schedule for this Contract.
 - c. Submit the structural steel fabricator's qualifications to the Program/Project Manager for approval, including a list of completed projects with project name, addresses, names of designers and owners, and other information applicable.
 - 3. Structural Steel Erector Qualifications:
 - a. Employ a structural steel erector experienced in erecting structural steel work similar to that required for this Contract who has a minimum of 5 continuous years of providing successful in-service performance.
 - b. Submit the structural steel erector's qualifications to the Program/Project Manager for approval.
 - 4. Professional Engineer Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform structural analysis required for the structural systems.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.
- C. Certifications:
- 1. Certificates of Analysis for Structural Steel:
 - a. Prior to providing the structural steel for the structure mounted signs provided under this Section, submit Certificates of Analysis for the structural steel to the Program/Project Manager for approval.
 - b. Include the following information in each Certificates of Analysis:
 - 1) A description of the material supplied.
 - 2) The quantity of material represented by the Certificates of Analysis.
 - 3) The means of identifying the material, such as a label, lot number, or other marking.
 - 4) Results of the tests specified in this Section to validate the quality of the materials.



- 5) A statement certifying that the material complies in all respects with the requirements specified, such as reference standards, tables, or Specification Sections.
 - 6) The name, title, signature, and date of the signature of a person having legal authority to bind the manufacturer or Supplier of the material or manufactured assembly.
 - c. Do not have the person having the legal authority sign the Certificates of Analysis sign it before all other required information has been inserted on the Certificate.
 - 1) Do not alter, add to, or change in any way a Certificates of Analysis after the authorized signature has been affixed to the original Certificate, except notations of a clarifying nature, such as the Project number, which do not affect the basic requirements of the Certificate.
 - 2. Mill Test Reports for Structural Steel Shapes, Plates, and Bars:
 - a. Submit structural steel mill test reports for structural steel shapes, plates, and bars signed by the manufacturer of the structural steel products, and certifying the products provided comply with the specified requirements, to the Program/Project Manager for information
 - 1) Include the results of the Charpy V-notch impact tests.
 - 2) Certify the material provided conforms to the appropriate ASTM specification.
- D. Sustainability Standards Certifications:
- 1. Recycled Steel:
 - a. Provide steel with the average recycled content of steel products includes a postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - b. Submit written affidavits from the steel manufacturer verifying that the recycled steel content provided complies with the specified requirements.
 - 2. Recycled Content ENVISION Submittals:
 - a. Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Because these credits are based on costs, include a statement indicating the costs for each product having recycled content.



PART 2 PRODUCTS

2.01 STRUCTURE MOUNTED SIGN ASSEMBLIES

- A. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
- B. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1. Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials
- C. Design Criteria:
 - 1. Shop Drawings:
 - a. Prior to fabrication of the sign structures, prepare Shop Drawings of the structures showing fabrication and installation details for the proposed sign structures.
 - 1) Include a complete design of the structure.
 - 2) Prepare Shop Drawings on 36-inch by 22-inch sheets having a 2-inch margin on the left side and 1/2-inch margins on the 3 remaining sides.
 - a) Furnish a 4-inch wide by 3-inch high blank space in the lower right hand corners of the sheets.
 - 3) Furnish details as required to represent the Work adequately, including details of the components and connection details.
 - 4) Shop Drawings containing drawings for falsework, shoring, soldier piles, and other major temporary structures must be sealed and signed by the Professional Engineer.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- D. Materials:
 - 1. Concrete:
 - a. For sign foundations, provide concrete complying with the requirements for Class A concrete (ADOT Class S concrete) having a



28-day compressive strength of 3000 psi specified in Section 03300, Cast-In-Place Concrete.

2. Fasteners
 - a. Bolts, Nuts, and Washers:
 - 1) For high strength bolts, nuts, and washers, provide steel bolts, nuts, and washers complying with the requirements specified in ASTM A 325.
 - 2) For other than high strength bolts, nuts, and washers, provide steel bolts and nuts complying with the requirements specified in ASTM A 307, and provide commercial quality washers.
 - b. Anchor Bolts:
 - 1) For the sign foundations, provide anchor bolts complying with the requirements specified in ASTM A 36/A 36M.
 - c. Except for the high strength bolts and the anchor bolts, either cadmium plate the fasteners in accordance with the requirements specified in ASTM B 766, or zinc plate the fasteners in accordance with the requirements specified in ASTM B 633.
3. Nonshrink Grout:
 - a. Provide nonshrink grout complying with the requirements specified in COE CRD-C 621.
 - 1) Submit Product Data for the nonshrink grout to the Program/Project Manager for approval.
4. Reinforcing Steel:
 - a. Reinforcing Steel Bars:
 - 1) Provide reinforcing steel bars complying with the requirements for Grade 40 steel specified in ASTM A 615/A 615M.
 - b. Reinforcing Steel Wire:
 - 1) Provide reinforcing steel wire complying with the requirements specified in ASTM A 82/A 82M.
5. Sign Panels:
 - a. Furnish sign panels complying with the requirements for sign panels specified in Section 02891, Post-Mounted Signs.
6. Structural Steel:
 - a. Structural Shapes, Plates, and Bars:
 - 1) Provide structural shapes, plates, and bars conforming to the requirements of ASTM A 36/A 36M.
 - 2) For column or girder flanges, web plates, and truss cord angles, provide structural steel complying with the minimum longitudinal Charpy V-notch (CVN) impact test values indicated in Table 02892-1, when tested in accordance with the following requirements:



- a) Employ sampling procedures complying with the requirements specified in ASTM A 673/A 673M.
- b) For structural steels complying with the requirements specified in ASTM A 36/A 36M, ASTM A 572/A 572M, and ASTM A 588/A 588M, employ the H (heat) testing frequency.
- c) For structural steels complying with the requirements specified in ASTM A 514/A 514M, employ the P (piece) testing frequency.
- d) Determine the Charpy V-notch (CVN) impact values in accordance with the requirements specified in ASTM E 23.

Table 02892-1 Minimum Charpy V-Notch Values for Structural Steel Shapes, Plates, and Bars		
Material Specification	Thickness	Impact Value (Foot-pounds at the Temperature Indicated)
ASTM A 36/A 36M	All	15 at 40 degrees Fahrenheit
ASTM A 572/A 572M ⁽¹⁾	All	15 at 40 degrees Fahrenheit
ASTM A 588/A 588M ⁽¹⁾	2 inches and under	15 at 40 degrees Fahrenheit
	Over 2 to 4 inches	20 at 40 degrees Fahrenheit
ASTM A 514/A 514M	2-1/2 inches and under	25 at 0 degrees Fahrenheit
	Over 2-1/2 to 4 inches	35 at 0 degrees Fahrenheit
1. If the yield point of the material exceeds 65,000 psi, reduce the temperature for the acceptable CVN impact value 15 degrees Fahrenheit for each increment of 10,000 psi above 65,000 psi.		

b. Tapered Tubes:



- 1) For the bridge single beam sign structures and for the cantilever double arm sign structures, provide tapered tube beams, arms, and poles fabricated from structural steel complying with the requirements specified for Grade A steel in ASTM A 595/A 595M.
- c. Pipe Poles:
 - 1) For cantilever truss, provide welded or seamless steel pipe poles complying with the requirements for Type E or Type S, Grade B steel specified in ASTM A 53/A 53M.
- E. Shop Fabrication:
 1. Fabricate component parts of the sign structures in accordance with the approved Shop Drawings and the requirements specified in Division II Construction, Section 11 Steel Structures, of the AASHTO Standard Specifications for Highway Bridges.
 2. Drill and tap structure components for mounting hardware as shown on approved Shop Drawings prior to installation.
 3. Welding:
 - a. Weld tubular structural steel in accordance with the requirements specified in Section 10 of AWS D1.1/D1.1M.
 - b. Weld structural steel other than tubular structural steel in accordance with the requirements specified in AWS D1.5/D1.5M.
 - c. The electro-slag welding process is unacceptable for welding structural steel.
 - d. In addition to the above requirements, weld Fracture Critical Members (FCMs) in accordance with the requirements specified in the AASHTO LRFD Bridge Design Specifications and AWS D1.1/D1.1M.
- F. Shop Finishing Methods:
 1. After sign structures have been fabricated, but before they have been assembled, galvanize all steel surfaces in accordance with the requirements specified in ASTM A 123/A 123M and ASTM A 153/A 153M.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
- B. Non-Conforming Work:
 1. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection



later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

C. Manufacturer Services:

1. Arrange for the producer to cooperate with and assist the Testing and Inspection Agency and code-required Approved Agency to inspect the materials at the source.

D. Coordination of Other Tests and Inspections:

1. Notify the Testing and Inspection Agency and the code-required Approved Agency responsible for performing special inspections sufficiently in advance of when structural steel for this Contract is being fabricated and/or tested to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - a. Do not begin fabrication of steel components until arrangements to allow inspection of these components in the shop have been completed.
 - 1) Furnish written notice to the Program/Project Manager at least 3 months prior to beginning shop fabrication of the steel components.
 - 2) Furnish verbal notice to the Program/Project Manager at least 24 hours prior to beginning shop fabrication of the steel components.
 - b. The Testing and Inspection Agency and the code-required Approved Agency may perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
2. Cooperate with and assist the Testing and Inspection Agency and code-required Approved Agency when they are performing required material verifications and other special inspections at the source.
 - a. Provide full access to the places where structural steel work is being fabricated or produced so the required inspections and testing can be performed before the material is shipped.
 - b. Furnish and maintain adequate safety measures when the materials being furnished as the Work of this Section are being manufactured or produced and inspected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:



1. Prior to scheduling installation of the sign structures, verify that the Work performed by other trades at the locations for the sign structures is complete, and these locations are ready for installation of the sign structures.

3.02 INSTALLATION

A. Foundation Installation:

1. Construct reinforced concrete foundations for the sign structures as shown on the ADOT Standard Drawings and the Contract Drawings.
 - a. Form and construct foundations within drilled shaft excavations as specified in Section 02473, Drilled Concrete Shafts.
 - b. Set each foundation at the elevation indicated on the Contract Drawings.
 - c. Place, finish, and cure concrete in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete.
2. Grade embankment to match the top of the foundation as directed by the Program/Project Manager.

B. Sign Structure Installation:

1. Erect sign structures in accordance with the Contract Drawings; ADOT Standard Drawings; Division II Construction, Section 11 Steel Structures, in the AASHTO Standard Specifications for Highway Bridges, and as noted in this Section.
2. Provide temporary shores, guys, braces, and other supports during erection to keep sign structure secure, plumb, and in alignment.
 - a. Use temporary bracing to resist loads to which the structures may be subjected, including loads from erection equipment or its operation.
 - b. Leave temporary bracing in place as long as may be required for safety.
3. Erect steel structures true and plumb in accordance with the Contract Drawings, match marks, and pertinent regulations.
 - a. Do not field cut or alter structural members.
 - b. Do not straighten bent members unless approved by the Program/Project Manager.

C. Bolt Installation:

1. Lubricate galvanized nuts with a lubricant containing a visible dye so a visual check for the lubricant can be made during field installation.
2. Black bolts must be oily to the touch when installed.
 - a. Clean and re-lubricate weathered or rusted bolts prior to installation.



3. Install high-strength bolts, nuts, and washers in accordance with paragraph 11.5.6.4 Installation of the AASHTO Standard Specifications for Highway Bridges.
 - a. For all final tightening methods, obtain a “snug tight” condition as defined in paragraph 11.5.6.4.4 of the AASHTO Standard Specifications for Highway Bridges.

D. Welding:

1. Weld tubular structural steel in accordance with the requirements specified in Section 10 of AWS D1.1/D1.1M.
2. Weld structural steel other than tubular structural steel in accordance with the requirements specified in AWS D1.5/D1.5M.
3. The electro-slag welding process is unacceptable for welding structural steel.
4. In addition to the above requirements, weld Fracture Critical Members (FCMs) in accordance with the requirements specified in the AASHTO LRFD Bridge Design Specifications and AWS D1.1/D1.1M.

E. Grouting:

1. Mix, handle, and place grout in accordance with the manufacturer’s recommendations.
 - a. Submit the manufacturer’s recommendations for mixing, handling, and placing grout to the Program/Project Manager for information.

3.03 REPAIR

A. Galvanized Surfaces:

1. Clean field welds, bolted connections, and abraded areas, and repair galvanizing in accordance with the requirements specified in ASTM A 780.

B. Repair damage to structural components resulting from the Contractor’s operations at no increase in the Contract Price.

1. If the damage cannot be repaired, replace the damaged components with new, sound components in part or the whole of the structure at no increase in the Contract Price.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Testing:
 - a. Bolt Tension Test:
 - 1) Test Procedure:



- a) As-installed bolt/nut/washer assemblies will be periodically tested of using a Skidmore-Wilhelm Calibrator or other acceptable bolt tension indicating device to ensure the assemblies comply with the specified requirements.
 - (1) Calibrated wrench tightened assemblies will be tested on a daily basis.
 - (2) For short grip bolts, a direct tension indicator (DTI) that has been first checked with a longer bolt in the Skidmore-Wilhelm Calibrator may be used to verify compliance.
 - 2) Acceptance Criteria:
 - a) Bolt/nut/washer assemblies complying with the specified bolt tensions will pass the bolt tension test.
 - b. Weld Test:
 - 1) Test Procedure:
 - a) Column to base plate welds and pipe flange to elbow and mast arm welds will be tested using ultrasonic methods.
 - 2) Acceptance Criteria:
 - a) Welds complying with the acceptance criteria specified in the welding standards for the type of weld tested will pass the weld test.
 - 2. Inspections:
 - a. The Program/Project Manager will inspect completely installed signs for proper appearance, visibility, color, specular gloss, and proper installation.
- B. Non-Conforming Work
- 1. Correct apparent sign panel defects disclosed by the Program/Project Manager's inspection at no increase in Contract Price.
 - a. If color variations or blemishes between sign panel increments are visible from a distance of 50 feet either during the day or at night, remove the defective panels and replace them with new panels.

3.05 CLEANING

- A. Just prior to inspection of the signs by the Program/Project Manager, thoroughly clean the sign panel faces using a method recommended by the manufacturer.
 - 1. Furnish cleaning solvent and cleaning materials that do not scratch, deface, or cause adverse effects on the sign panel components.



3.06 PROTECTION

- A. Preserve all roadway signs and sign supports, and replace new roadway signs and sign supports damaged as a result of construction at no increase in Contract Price.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First edition.
1	01/09/2018	N/A	Various	Add requirements for ENVISION Sustainability Rating System



SECTION 02893

TRAFFIC SIGNAL SUPPORTS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing traffic signal equipment at the locations indicated on the Contract Drawings.
 - a. The Work of this Section includes the labor, incidental materials, and transportation and storage associated with the completion of the installation as shown on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AWG: American Wire Gage.
 - 2. DCS: City of Phoenix Design and Construction Services Division.
 - 3. LED: Light Emitting Diode.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - 2. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction.
 - 3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM B 3 - Standard Specification for Soft or Annealed Copper Wire.
 - d. ASTM B 85 - Standard Specification for Aluminum-Alloy Die Castings.
 - e. ASTM D 4066 - Standard Specification for Nylon Injection and Extrusion Materials.



4. City of Phoenix (COP):
 - a. City of Phoenix Supplement to Maricopa Association of Governments Uniform Standard Specifications.
 - b. City of Phoenix Street Transportation Department:
 - 1) Traffic Signal Standard Details:
 - a) File No.7690, Sheet 1 of 6 – General Notes Signal Location.
 - b) File No.7690, Sheet 2 of 6 – General Notes Signal Location.
 - c) File No.7690, Sheet 3 of 6 – General Notes Signal Location.
 - d) File No.7690, Sheet 4 of 6 – Type ‘SM’ for 15’ – 20’ Mast Arms Signal Location.
 - e) File No.7690, Sheet 5 of 6 – Type ‘SM’ for 25’ – 30’ Mast Arms Signal Location.
 - f) File No.7690, Sheet 6 of 6 – Type ‘SR’ (Spec. Comb. Pole) for 40’ – 55’ Mast Arms Signal Location.
5. Institute of Transportation Engineers (ITE):
 - a. ITE Interim LED Purchase Specification (1998).
6. International Municipal Signal Association (IMSA):
 - a. IMSA Specification No. 19-1 1991 Polyethylene insulated, Polyethylene Jacketed Communication Cable.
 - b. IMSA Specification No. 50-2 Polyethylene Insulated, Polyethylene Jacketed Loop Detector Lead-In Cable.
 - c. IMSA Specification No. 51- 3 Cross Linked Polyethylene Insulated Loop Detector Wire.
7. Maricopa Association of Governments (MAG):
 - a. MAG Uniform Standard Specifications for Public Works Construction.
8. Underwriters Laboratories Inc.
 - a. UL 83 - Standard for Safety Thermoplastic-Insulated Wires and Cables.
9. United States Government:
 - a. U.S. Department of Transportation (USDOT).
 - 1) Federal Highway Administration (FHWA).
 - a) Manual on Uniform Traffic Control Devices (MUTCD).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate street closings and traffic control with the City of Phoenix Street Transportation Department Traffic Operations Division, the City of Phoenix Right-of-Way Management program, and with other appropriate government agencies.
 - a. Obtain all permits required by the City of Phoenix, and pay necessary fees.
 2. Coordinate all utility related work during traffic signal work activities with Aviation Facilities and Services at Phoenix Sky Harbor International Airport to avoid tapping into established utilities.



3. Forward all utility information to the Design and Construction Services Division (DCS) of the Phoenix Sky Harbor International Airport.
4. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to schedule shut downs of utilities and services
5. Obtain the approval of serving utilities and/or the Phoenix Sky Harbor International Airport as applicable to disconnect, relocate, and/or provide temporary or new utility service connections and lines as needed if these have not been previously completed.

B. Sequencing:

1. Include provisions for traffic control during installation of the traffic signal supports and equipment in the Traffic Control Plan required by Section 01555, Traffic Control, including provisions for the placement and maintenance of barriers required to protect the workers and the public during removal operations.
 - a. Prepare traffic control and walkway plans required by the City of Phoenix Special Traffic Regulations.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Conduit, couplings, and pull boxes.
 - 2) Signal faces and wiring, including loop detection.
 - 3) Internally Illuminated Street Name Signs (IISNS).
 - 4) Luminaires.
 - 5) Power service cabinet.
 - 6) Traffic signal controller and cabinet and cabinet contents.
 - b. Shop Drawings:
 - 1) Layout drawings.
 - 2) Sign and mounting details for the internally illuminated street name signs.
 - c. Qualification Statements:
 - 1) IMSA technician/electrician's qualifications.
 - 2) Electricians' qualifications.

B. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built information for traffic signal equipment.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. An International Municipal Signal Association (IMSA) Technician/Electrician must be onsite at all times during construction of the traffic signal supports and equipment.
- B. Qualifications:
 - 1. International Municipal Signal Association (IMSA) Technician/Electrician's Qualifications:
 - a. Employ a Level II IMSA-certified Technician/Electrician.
 - b. Submit the International Municipal Signal Association (IMSA) technician/electrician's qualifications to the Program/Project Manager for approval.
 - 2. Electricians' Qualifications:
 - a. Employ a qualified Journeyman Electrician, who has successfully completed a recognized 4-year electrical apprenticeship program or equivalent training, or a person enrolled in a recognized 4-year electrical apprenticeship program under the direct supervision of a Journeyman Electrician.
 - b. Submit the electricians' qualifications to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Product Data:
 - 1. Submit Product Data for the products and materials proposed for the Work of this Section to the Program/Project Manager for approval.
 - 2. All products and materials must be approved by the Program/Project Manager prior to ordering.
- B. Shop Drawings:
 - 1. Submit layout drawings for traffic signal poles and mast arms, including structural calculations, to the Program/Project Manager for approval.

2.02 MATERIALS

- A. Foundations for Poles, Power Service Pedestals and Cabinets:
 - 1. Provide foundations and associated hardware conforming to COP Street Transportation Department File No.7690.
 - 2. For foundations, provide Class A, 3000 psi concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete, and having a 6 inch slump.
- B. Traffic Signal Conduit



1. Provide schedule 40 rigid polyvinyl chloride (PVC traffic signal conduit) complying with the requirements specified in Section 732-2.02 of the ADOT Standard Specifications for Road and Bridge Construction.
- C. Junction Boxes
1. Provide junction boxes complying with the requirements specified in Section 732-2.03 of the ADOT Standard Specifications for Road and Bridge Construction, except as modified herein.
 - a. Provide lids embossed in minimum 1 inch tall lettering parallel to the longest side to read "TRAFFIC SIGNAL".
- D. Poles and Mast Arms
1. Provide traffic signal poles, mast arms, and the associated hardware in conformance with COP Street Transportation Department File No.7690.
- E. Twelve (12) Inch Signal Heads
1. Provide twelve Inch traffic signal head assemblies consisting of Light Emitting Diode (LED) vehicle signal displays of Red, Yellow, and Green Ball or Arrow sections equipped with a back plate, visor, and associated mounting hardware for pole or mast arm mounting, as indicated on the Contract Drawings.
 - a. Traffic signal head assemblies consist of individual sections, fastened together to produce a single unit.
 - b. Provide sections that fit securely together to prevent the entrance of dirt and moisture into the assembly.
 2. 12-inch signal head sections each require the following:
 - a. Section Housing:
 - 1) Provide one-piece, polycarbonate housings for each section, complete with a top, a bottom, and sides and with black color impregnated into the material.
 - 2) Equip each section housing with a rectangular polycarbonate door meeting the minimum requirements of ASTM B 85.
 - 3) Provide 2 hinge lugs on the left of each housing section, and latch screw lugs on the right side of the housing.
 - 4) Provide an opening on the top and bottom of the housing to accommodate standard 1-1/2 inch pipe fittings.
 - 5) Provide a Shurlock boss in the bottom opening of the signal housing having 72 clean, sharp clean teeth that provide full engagement, angled at 90 degrees with a depth of 5/64 inch.
 - 6) The radial angular grooves of the Shurlock boss, when used with Shurlock fittings must provide positive positioning of the entire signal head and eliminate rotation or misalignment of the signal.
 - 7) Provide the top of the section housing with two indentations in the opening designed to receive a Shurlock ring to provide positive positioning of the head when mounted from a mast arm.



- 8) Provide each housing section with a minimum of 4 mounting points, 2 on each side, to secure the back plate to the signal head.
- b. Housing Doors:
 - 1) Provide housing door, each consisting of a one-piece, polycarbonate housing door for each signal section with black color impregnated into the material.
 - 2) Provide 2 hinge lugs on the left of each door, and latch paws on the right side of each door.
 - 3) Provide hinge pins easily removable without the need for special tools.
 - 4) Provide a corrosion resistant, stainless steel latch screw and wing nut on the right side of the housing to allow opening and closing the signal door without the use of any tools.
 - 5) Form the inside of the door with a gasket groove having a weather-proof and mildew resistant resilient polyethylene gasket which, when the door is closed, seats against a raised bead on the housing to make a positive weather proof and dustproof seal.
 - 6) On the outer face of the door and equally spaced about the circumference of the lens opening, provide 4 tapped holes to accommodate the signal head visor.
 - a) Include four 18-8 Type 304 stainless steel truss head screws to accommodate the signal head visor.
- c. Signal Head Visors:
 - 1) Equip each signal place with a tunnel style (open bottom) visor that is approximately 7 to 10 inches long.
 - 2) Provide visors blanked, formed, and welded from .050 inch 31 05-H25 aluminum alloy or polycarbonate.
 - 3) Design and fabricate visors with attaching ears (slotted tabs) to facilitate installation.
 - 4) Construct the visor so it can be installed or removed from the signal head without removing the attaching screws or opening the housing door.
 - 5) The axis of the visor may not deviate more than 3.5 degrees or less than 3 degrees downward from horizontal.
- d. Light Emitting Diode (LED) Vehicle Signal Module:
 - 1) Equip each signal section with an LED vehicle signal module for each signal head section, including balls and arrows.
 - 2) Provide LED traffic signal modules meeting the requirements identified in the 1998 interim LED Purchase Specification of the institute of Transportation Engineers except as may be herein listed.
 - a) Provide LED traffic signal modules of a design that will fit traffic signal housings complying with the Specifications established herein.



- b) Provide weather tight modules that fit securely in the housing and that will connect to the traffic signal head wire terminal block.
- c) Provide wiring having only crimped on terminal connectors.
- d) Provide a single, self-contained LED signal module.
 - (1) Provide a power supply integral to the sealed LED module.
- 3) Module identification:
 - a) Affix the manufacturer's label to each LED module.
 - b) Provide labels containing all information listed in Section 3.6 of the ITE Interim LED Purchase Specification, and containing the date of manufacture.
- 4) LED Environmental Requirements:
 - a) Provide LED signal modules rated for use in the ambient operating temperature range of – 40 degrees Celsius (- 40 degrees Fahrenheit) to +74 degrees Celsius (164 degrees Fahrenheit).
- 5) LED Module Photometric Requirements:
 - a) Provide LED modules having a light output complying with the requirements of Section 4 of the ITE Interim LED Purchase Specification, the 44-point test identified in paragraph 6.4.2.1, and the single point test identified in paragraph 6.4.2.2.
- 6) LED Module Electrical Requirements:
 - a) Provide an LED module that uses 2 color-coded copper wires
 - (1) Provide No. 20 AWG wire with 30 mil jacketed insulation.
 - (2) Provide wires a minimum of 36 inches long with crimped-on fork connectors.
 - (3) Provide wire rated for 600 volt AC.
 - (4) Provide insulation rated for 105 degrees Celsius (220 degrees Fahrenheit).
- 7) LED Dimming:
 - a) Do not equip the LED modules with dimming circuitry.
- 8) Failed State Impedance:
 - a) Have the LED module manufacturer include the option listed in Section 5.8 of the ITE Interim LED Purchase Specification.
- 9) LED Module Compatibility:
 - a) The recommendation stated in Technical Note #2 of the Institute of Transportation Engineers 1998 Interim LED Purchase Specification is adopted.
 - b) Provide LEDs compatible with approved load switches and conflict monitors.
 - (1) Include in the material submittal a list of all control equipment known to be incompatible with the submitted LED module.



- (a) This list is to include all known equipment as well as that employed in this Contract.
 - c) Currently the following brand and model load switches and conflict monitors are to be known to be compatible with the submitted module.
 - (1) Load Switches
 - PDC model SSS-83
 - PDC model SSS-87
 - PDC model SSS-88
 - IDC/SSD model 200K
 - IDC/SSD model 200K I/O
 - TSC C/N 82A049
 - TSC C/NSP 4300
 - EDI 510 m
 - (2) Conflict Monitors
 - Eagle model LT-222
 - Econolite model SSM-12E
 - EDI model NSM-12L
 - EDI model SSM-18LE
 - Solid State Devices model NM(NP)-12L
 - Solid State Devices model Guardian LCD 18P
- e. Wiring:
 - 1) Provide each LED module with color coded wiring.
 - 2) Relate the color code to the display provided by the module as follows:

Function	Color
Red Ball or Arrow Driver	Red
Yellow Ball or Arrow Driver	Yellow
Green Ball or Arrow Driver	Green
- 3. Terminal Blocks:
 - a. Equip each complete signal head with a 6-position, 12 terminal, barrier type strip terminal block phenolic terminal block.
 - b. Locate the terminal blocks in the in the bottom section of vertically arrayed signal head assemblies, and in the bottom green ball section of 5 section mast arm mounted side by side arrayed signal head assemblies.
 - c. Attach the red, yellow, and green signal section leads to the same side of the terminal strip.
- 4. Colors and Finishes:
 - a. Signal Head Color:
 - 1) Color the vehicle signal heads with black color impregnated into the material of the polycarbonate surfaces, including the inside and outside of the signal housing, the door, and the visors.
 - b. Back Plate Finish:



- 1) Finish the back plates with a low-gloss two-part high solids enamel paint with ultraviolet inhibitors.
- 2) Powder coating is an acceptable alternative.
5. Mounting Hardware:
 - a. For mast arm mounted signal head assemblies, install an elevator plumbizer below the red section of the signal head.
 - 1) When so equipped, provide the top and bottom sections of the assemblies with a gasketed closure in the 1-1/2-inch openings.
 - 2) Provide cast bronze elevator plumbizers cast smooth or machined to remove all sharp edges.
 - 3) When required, equip the signal head with a mast arm mounting bracket assembly consisting of a banded pole plate and 1-1/2-inch support tube designed for rigid mast arm mounting of a signal head equipped with an elevator plumbizer
 - b. For pole mounted signal heads, mount each signal head assembly with a set of brackets that includes the following:

Item	Quantity per Set
1 1/2 Pipe Elbow with serrated surface (72 teeth)	2
1 A" Chase Nipple with 2 1/2" Hex head	2
1 1/2" Schedule 40 Pipe arms	2
Band-on style pole brackets	2

- F. Traffic Signal Loop Detectors:
 1. Provide 5 feet by 40 feet inductive loop detectors at the locations indicated on the Contract Drawings.
 2. Size the inductive Loop Wire as indicated on the Contract Drawings and consistent with IMSA 51-3.
 3. Size the loop lead-in cable as indicated on the Contract Drawings and consistent with IMSA 50-2.
- G. Controllers and Cabinets:
 1. Provide a MPS 12 phase dual ring traffic signal controller conforming to the requirements specified in Section 734 of the ADOT Standard Specifications for Road and Bridge Construction for Road and Bridge Construction.
 2. Coordinate with the City of Phoenix Traffic Signal staff to determine the preferred traffic signal controller model and cabinet type.
 3. Provide a power service pedestal cabinet in accordance with the requirements specified in Section 734-2.03 (G) of the ADOT Standard Specifications for Road and Bridge Construction for Road and Bridge Construction.
 4. Verify that the cabinet to be installed is compatible with the cabinet foundations shown on the COP Street Transportation Department File No.7690.



H. Wire and Cable:

1. Signal Conductor Traffic Signal Cable:
 - a. Size traffic signal cable as indicated on the Contract Drawings and complying with the requirements specified in IMSA Specification 19-1.
 - b. For 5, 7, 20 or 42 conductor cable, provide AWG 14 solid copper conductors.
2. Single Conductor Signal Wire:
 - a. Provide single conductor signal wire consisting of a solid copper conductor insulated by a polyvinyl chloride compound, and sized as indicated on the Contract Drawings.
 - 1) Completely enclose the insulated conductor in a nylon jacket.
 - b. Provide copper conductor conforming to the requirements of ASTM B 3 before insulation is applied.
 - c. Insulate the conductor using polyvinyl chloride.
 - d. Apply the insulation concentrically about the conductor.
 - 1) Provide insulation for AWG 14 conductors not less than 13 mils thick.
 - 2) Provide insulation for AWG 10 conductors not less than 18 mils thick.
 - e. Provide insulation of the finished conductor capable of withstanding a 60 Hertz or 3,000 Hertz, 7,500 volt essentially sinusoidal spark test potential (RMS) before the jacket is applied without breakdown when tested in accordance with the method and using the equipment specified in UL 83.
 - f. Apply a tight fitting nylon compound jacket over the conductor complying with the requirements specified in ASTM D 4066.
 - g. Provide jacket not less than 0.003 inches thick on all conductors.

I. High Pressure Sodium Luminaries:

1. Provide 250 watt, high pressure sodium luminaries of the horizontal burning type complying with the requirements specified in Section 736-2.01 (A) of ADOT Standard Specifications for Road and Bridge Construction.

J. Internally Illuminated Street Name Sign:

1. Provide luminated sign fixtures having double face illuminated street sign cabinets.
 - a. Provide cabinets consisting of an aluminum extrusion with mill finish, and measuring approximately 96 inches wide, by 36 inches high, by 12 inches deep.
 - b. Provide cabinets having a top-hinged retainer system with prop rod for access and service.
 - c. To prevent vertical sagging of the cabinet, install 3/8-inch support rods in a double "X" pattern on each of the 2 display sides.
2. Provide white polycarbonate faces with 3M vinyl graphics:



- a. Provide a #3990 reflective diamond grade background with EC Film#1177 green.
- b. Font: HWY Gothic Series B, C, and/or D (2002) with standard spacing.
- c. Provide City of Phoenix logos consisting of printed vinyl graphics.
3. Provide faces consisting of the street name, the block, and direction number in the upper right hand corner above the City of Phoenix logo.
4. Where street name is different on each side of the intersection, display both street names, with arrows indicating the direction for each street name.
5. Have the City of Phoenix Street Transportation Department approve sign legends and layouts prior to ordering.
6. Provide illumination using two F96T12 CWHO 800mA fluorescent lamps on 10-inch centers horizontally, with an EESB-424-13L electronic ballast attached to an extruded wireway.
7. Hot-dip galvanize the steel bracket and mounting hardware components in accordance with ASTM A 123/A 123M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Prior to beginning construction operations, perform a field investigation with the Program/Project Manager.
 2. Prior to beginning excavation operations, mark in the field the foundation locations for poles, controller cabinets, and other foundations shown on the traffic signal plans in the Contract Drawings.
- B. Evaluation and Assessment:
 1. At the time of the inspection, the Program/Project Manager may adjust pole locations from the planned or marked locations to accommodate circumstances found at the Site.
 2. Before the excavation of any foundation may proceed, the Program/Project Manager must approve the foundation locations in writing.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities by construction operations.
 - a. Do not close or obstruct streets without permission from the Authorities Having Jurisdiction.
 - b. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.



- 1) Ensure safe passage of persons around the area of construction.

3.03 CONSTRUCTION

- A. Foundations for Poles, Power Service Pedestals and Cabinets:
 1. Provide foundations installed in accordance with the requirements specified in Section 731-3.01 of the ADOT Standard Specifications for Road and Bridge Construction, except as modified herein.
 2. The Contractor may employ the alternative foundation design for disturbed material only with prior approval of the Program/Project Manager.
 3. Cast foundations in a single continuous pour using the concrete specified.
 - a. Cold joints are not permitted.
 4. Pole Foundations:
 - a. The minimum curing time before loading is 10 days.
 - b. Quick curing compounds are unacceptable.
 - c. Provide conduits finished so they extend 6 inches above the finished grade of the foundation.
 - d. Provide anchor bolts extending above the finished grade of the foundation to the height specified for the specific pole type, as shown on COP Street Transportation Department File No.7690.
 5. Cabinet Foundations:
 - a. The minimum curing time before loading is 7 days.
 - b. Quick curing compounds are unacceptable.
 - c. Provide conduits finished flush with the finished grade of the top of the foundation.
 - d. Provide anchor bolts extending 4 inches above the finished grade of the foundation.
- B. Traffic Signal Conduit:
 1. Provide traffic signal conduit in accordance with the requirements specified in Section 732-3.01 of the ADOT Standard Specifications for Road and Bridge Construction, except as modified herein.
 2. Install traffic signal conduit a minimum of 30 inches below finished grade, except locate loop stub out conduits 6 inches to 12 inches below the curb base.
 3. Except for loop stub out conduits, encase traffic signal conduit having less than 30 inches of cover in concrete so there is a minimum of 2 inches of cover on all sides.
- C. Junction Boxes:
 1. Provide junction boxes in accordance with the requirements specified in Section 732-3.01 of the ADOT Standard Specifications for Road and Bridge Construction.
- D. Poles and Mast Arms:



1. Provide poles and mast arms in accordance with COP Street Transportation Department File Drawing #7690, and with the requirements specified in Section 731-3.02 of the ADOT Standard Specifications for Road and Bridge Construction.
- E. Twelve Inch Signal Heads:
1. Provide twelve inch signal head assemblies in accordance with the requirements specified in Section 733-3 of the ADOT Standard Specifications for Road and Bridge Construction.
- F. Traffic Signal Loop Detectors:
1. Locate traffic signal loops as shown on the Contract Drawings.
 - a. Before installing the loops, mark the loops in the field at the locations approved in writing by the Program/Project Manager.
 2. Saw-cut and drill slots and cores into the final asphalt concrete base course lift as shown in the COP Street Transportation Department File No.7690.
 - a. Provide 1/4-inch wide slots of sufficient depth to allow 2 inches of sealant coverage.
 - b. Drill cores 2-1/2 inches in diameter, and 2-1/2 inches deep.
 3. Install loop conductors only in the presence of the Program/Project Manager.
 - a. Blow out and dry slots before installing wires.
 - b. Wind each loop in the direction and with the number of turns indicated on the COP Street Transportation Department File No.7690.
 - c. Wind loop lead-in's from the loop to the junction box at three turns per foot.
 4. Band the beginning conductor in the junction with the symbol "S", and identify the loop by a number of taped rings as shown on the COP Street Transportation Department File No.7690.
 5. Provide each loop with a minimum of 3 feet of slack in the twisted pair of conductors at the junction box when measured from the top of the junction box.
 6. Connect loop conductors to shielded loop lead-in cables with twist-on wire nuts sealed with a commercial grade of silicone sealant.
 7. Only seal loops after completion of successful testing as specified in Article 3.04.
 8. Inject sealant into the slots and drill cores, and strike it off flush with the roadway surface.
 - a. Remove excess sealant from the surface of the roadway.
- G. Controllers and Cabinets:
1. Provide controllers and cabinets in accordance with the requirements specified in Section 734-3 of the ADOT Standard Specifications for Road and Bridge Construction.



H. Wire and Cable:

1. Provide traffic signal wire and cable in accordance with the requirements specified in Section 734-3.02 of the ADOT Standard Specifications for Road and Bridge Construction.
2. Conductor splices and terminations may only be made by a qualified Journeyman Electrician.

I. High Pressure Sodium Luminaries:

1. Provide luminaries in accordance with the requirements specified in Section 736-3 of the ADOT Standard Specifications for Road and Bridge Construction.

J. Internally Illuminated Street Name Signs:

1. Mount sign cabinets on the luminaire extension of the traffic signal poles as indicated in the Contract Drawings.
2. Ensure that the base of the cabinet clears the traffic signal mast arm by a minimum of 8 inches at the cabinet's outer edge.
3. Ensure that the top of the cabinet clears the luminaire mast arm base by a minimum of 8 inches at the cabinet's outer edge.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Testing must be conducted in the presence of the Program/Project Manager.
 - a. Successful completion of tests will be documented in writing by the Program/Project Manager.
2. Meggar Test:
 - a. Test Procedure:
 - 1) Perform a 600 volt meggar test on the traffic signal loop detectors.
 - b. Acceptance Criteria:
 - 1) A 600 volt meggar test showing not less than 10 megohms resistance to ground is acceptable.
 - 2)
3. Continuity Test:
 - a. Test Procedure:
 - 1) Perform a continuity test on the traffic signal loop detectors.
 - b. Acceptance Criteria:
 - 1) A continuity test showing loop circuit resistance does not exceed 2 ohms is acceptable.
4. Inspections:
 - a. Record and prepare as-built information for traffic signal equipment both above and below ground.
 - 1) Submit the as-built information for traffic signal equipment to the Program/Project Manager for the record.



3.05 SYSTEM STARTUP

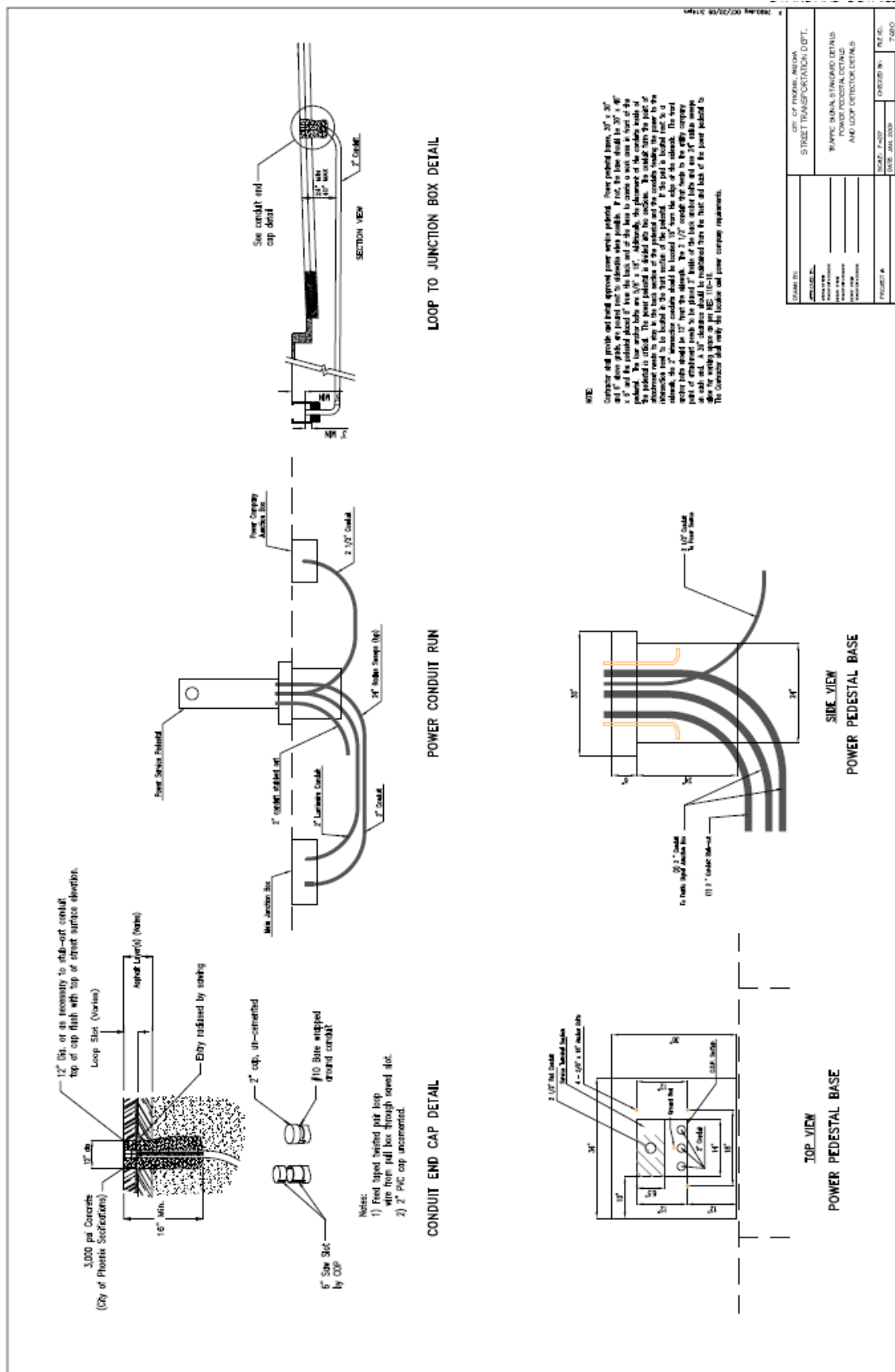
- A. Final acceptance of the traffic signal system will be determined by the Program/Project Manager after all discrepancies and/or modifications are completed.

3.06 ATTACHMENTS

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
 - 1. COP Street Transportation Department File No.7690.

END OF SECTION

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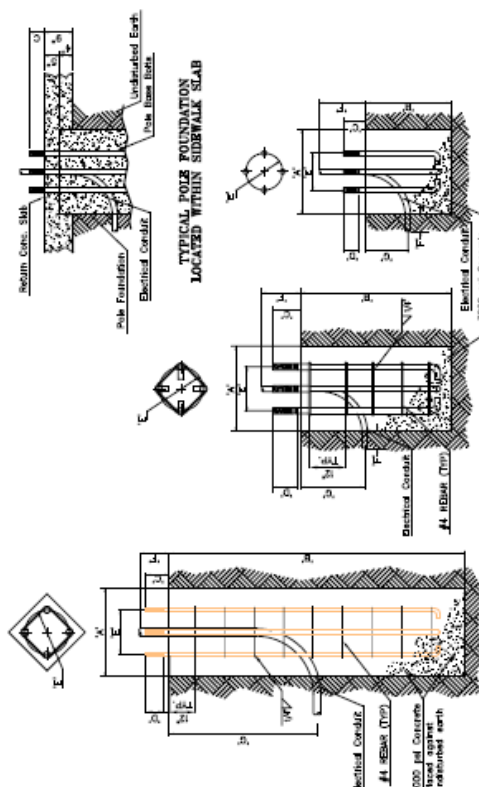


TRAFFIC SIGNAL STANDARD SYMBOLS

EQUIPMENT LEGEND	
EQUIPMENT SYMBOL	EQUIPMENT DESCRIPTION
	Traffic Signal Pole
	Mid-Size LED Side
	A-10 Mid-Size Pole
	Hand Side
	Pole Location
	Equipment Number
	Head Height (to be used in Equipment Schedule tab)
	Loop Detector
	Traffic Signal Mast Arm w/Signed Head
	Traffic Signal Mast Arm w/Traffic Arrows
	Pedestrian Head
	Audible Pedestrian Device
	Pedestrian Push Button
	Audible Pedestrian Station
	Traffic Signal Pole w/Flat Arm & Signed Head
	Traffic Signal Pole w/Flat Arm, Signal Head & Luminaires
	Pole-mounted Traffic Signal Controller Cabinet
	Pole-mounted Traffic Signal Controller Cabinet
	Power Service Indicated
	Street Light
	CCTV Camera
	Privacy Screen
	Video Storage

UNDERGROUND LEGEND		
PREPARED SYMBOL	LEGEND SYMBOL	DESCRIPTION
—	○	No. 3 1/2 Jarline Box
—	○	No. 6 Jarline Box
—	□	No. 7 Jarline Box
—	○	Traffic Signal Post/Marker
—	○	P.A.C. Symbol Designation
—	○	Preexisting Jarline Box Number
—	—	Location of Cable Man
—	—	Long Shink Set
—	—	Location Sign
—	□	Power Service Federal Post/Marker
—	—	Red Arrow Sign - Signal Control Area - Roadway

PROJECT # _____ NAME _____ DATE _____	CITY OF PHOENIX, ARIZONA STREET TRANSPORTATION DEPT. TRAFFIC SIGNAL STANDARD DETAILS FOUNDATION TYPES CEMENT/CLAY POLYMER CONCRETES
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UTILITY OF PHOENIX TYPE "A"
POLE FOUNDATION DETAIL
(NO SCALE)

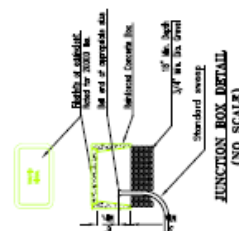
CITY OF PHOENIX
TYPE "M" & "LM"
POLE FOUNDATION DETAIL
(NO SCALE)

POLE FOUNDATION DETAIL
(NO SCALE)

POLE FOUNDATION DIMENSION SCHEDULE												
FOUNDATION POLE TYPE	POLE RETAIL (Ht.) MIN. MIN. HEIGHT	LIMBIC ADAPTABLE	FOUNDATION RETAIL (Ht.)			BAL RETAIL (Ht.)				CONDUIT RETAIL		
			"W" WIDTH	"W" DEPTH	DIA. ADAPTABLE	LENGTH OVERALL	"W" PROJECTION	"W" THREAD	"W" BOLT CIRCUM.	"W" CLEAR	"W" MIN. DEPTH	
TYPE "A"	14	N/A	18	38	1	40	5	4	10 1/2	6	24	
TYPE "W", "L"	20	15-25	YES	24	58	1 1/8	90	7	6	12 1/2	6	24
TYPE "SW"	20	15-25	YES	30	104	1 1/4	90	8 1/2	8	18 1/2	6	24
TYPE "S"	20	40-55	YES	30	120	2	108	8 1/2	8	18	6	24

* CONDUIT SHALL ENTER 2" MINIMUM LEG, VERTICALLY THROUGH THE CENTER OF THE FOUNDATION

CONCRETE SHALL BE PLACED VERTICALLY THROUGH THE CENTER OF THE FOUNDATION

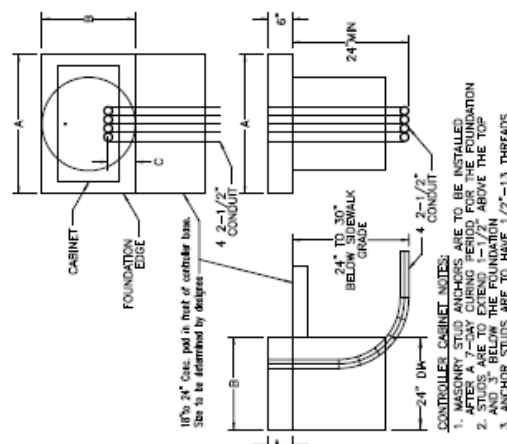


drawn rectangle

CONTROLLER CABINET FOUNDATION DIMENSION SCHEDULE			
CONTROLLER RACK	FOUNDATION LENGTH "L"	FOUNDATION WIDTH "W"	CONDUIT LOCATION "C"

GENERAL NOTES

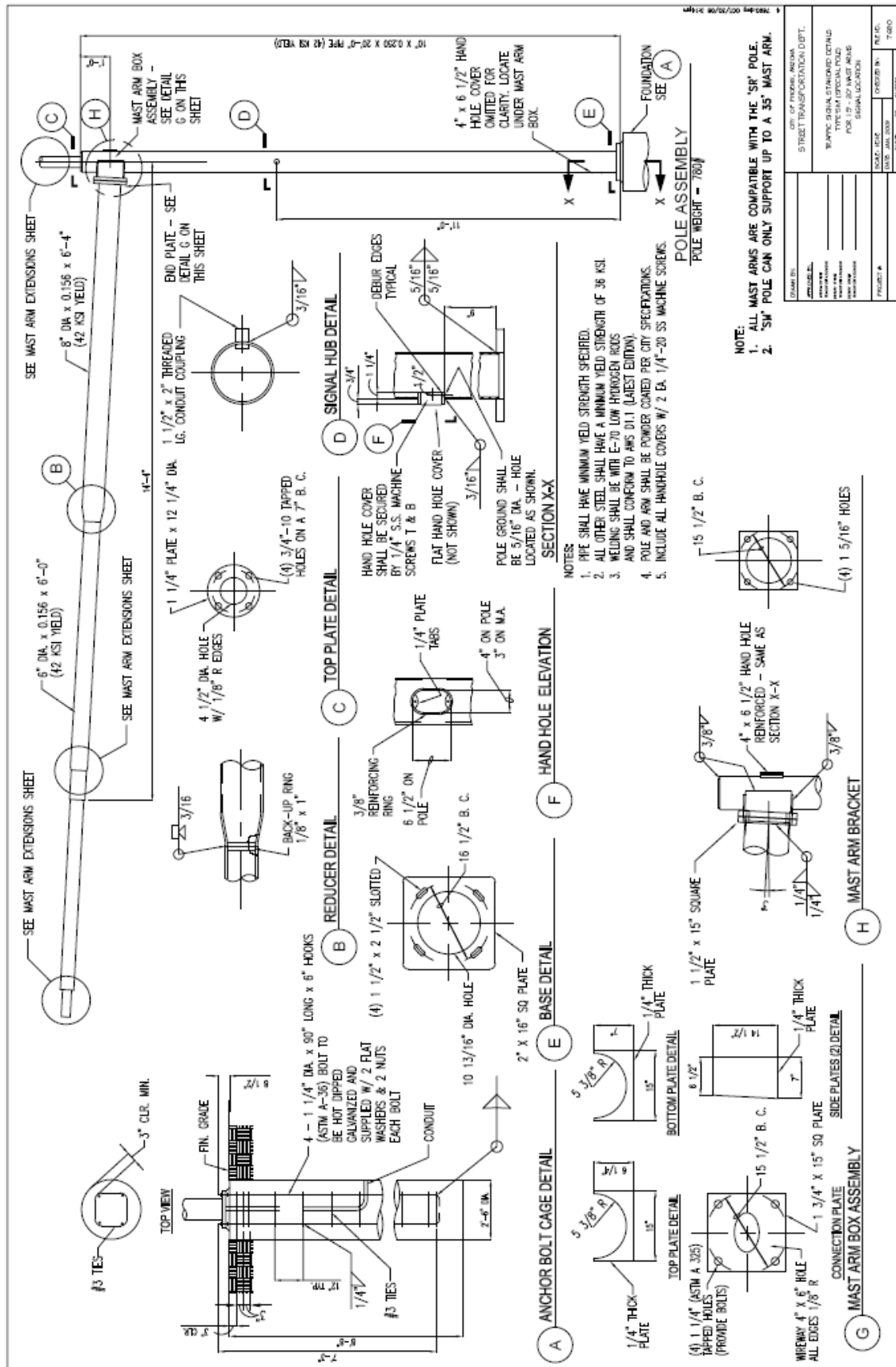
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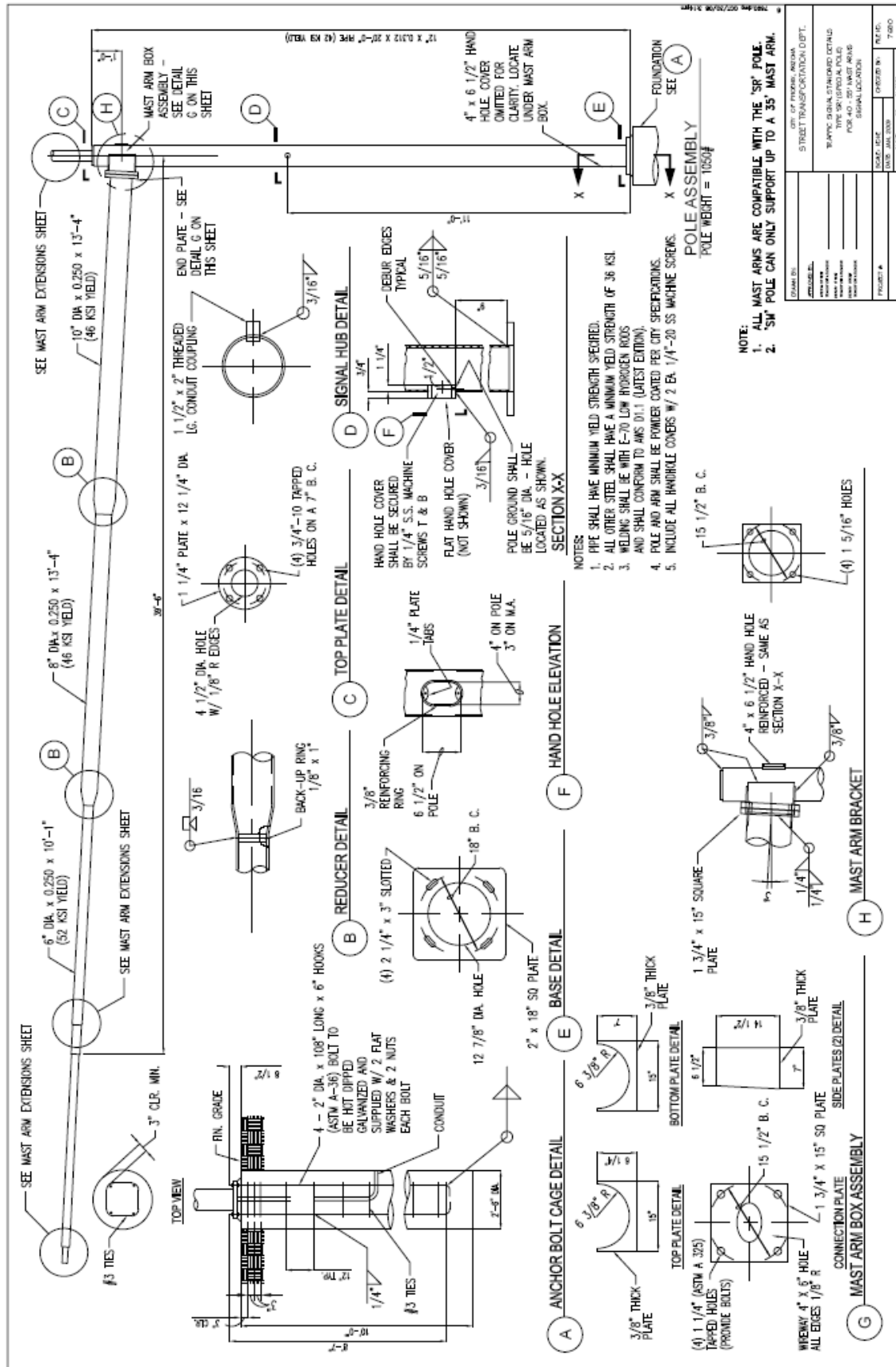


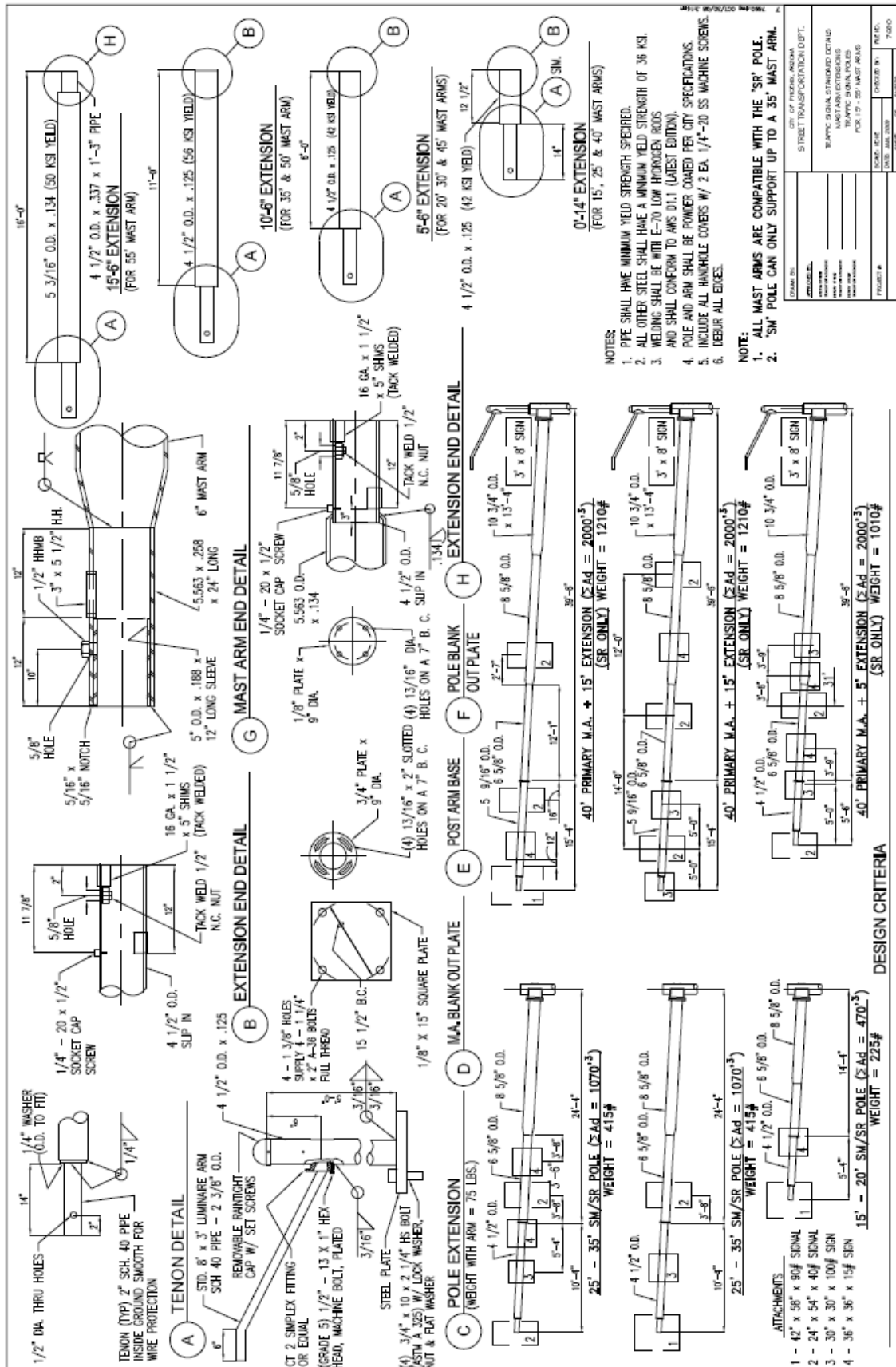
CONDUIT

- CONTROLLER. NOTE: MASONRY STUD ANCHORS ARE TO BE INSTALLED AFTER A 7-DAY CURING PERIOD FOR THE FOUNDATION. STUDS ARE TO EXTEND 1-1/2" ABOVE THE TOP AND 3" BELOW THE FOUNDATION. ANCHOR STUDS ARE TO HAVE 1/2"-1 1/4" THREADS.

ROLLER CABINET
HIDATION DETAIL
(NO SCALE)









REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First Edition



SECTION 02900

PLANTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for landscape plantings, including, but not limited to, the following:
 - a. Furnishing and planting landscape plantings.
 - b. Selective pruning.
 - c. Mulching.
 - d. Fertilizing.
 - e. Watering.
 - f. Providing maintenance for deciduous trees, palms, shrubs, and cacti.
 - g. Decomposed granite replacement.
 - h. Disposal of extraneous landscaping materials.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01410 - Regulatory Requirements.
 - 3. Section 01500 - Temporary Facilities and Controls.
 - 4. MAG Section 401 - Traffic Control.
 - 5. Section 01568 - Temporary Tree and Plant Protection.
 - 6. Section 01571 - Temporary Erosion and Sediment Control.
 - 7. Section 01770 - Closeout Procedures.
 - 8. Section 02237 - Plant Salvage.
 - 9. Section 02919 - Topsoil.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. APS: Arizona Public Service, an electric utility.
 - 2. SRP: Salt River Project, a Utility Company
 - 3. PLS: Pure live seed.
- B. Definitions:
 - 1. Tackifier: A soil penetrating substance used to bind soil and fertilizer particles together, hold seed in place while the seed germinates, and allow water and nutrients to reach the root zone of plants.
- C. Reference Standards:



1. American Nursery and Landscape Association (ANLA™)/American National Standards Institute (ANSI):
 - a. ANSI Z60.1, American Standard for Nursery Stock.
2. American Joint Committee on Horticultural Nomenclature (AJCHN):
 - a. AJCHN Standardized Plant Names.
3. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO T 89, Standard Method of Test for Determining the Liquid Limit of Soils.
4. Arizona Nursery Association (ANA):
 - a. ANA Grower's Committee Recommended Tree Specifications.
5. Arizona State Department of Agriculture:
 - a. Regulations for nursery observations, rules, and ratings.
 - b. Regulations for native plants.
6. Association of Analytical Communities International (AOAC):
 - a. AOAC Official Methods of Analysis of AOAC International.
7. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit,
 - 3) Dust Control Logs.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
 - 2) Regulation III – Control of Air Contaminants:
 - a) Rule 300 – Visible Emissions,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/300-0803.pdf.
 - b) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
 - c) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.
8. U. S. Government:
 - a. Department of Agriculture (USDA):
 - 1) 7 CFR 201 – Federal Seed Act Regulations.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate planting activities with anticipated phasing and sequencing of other construction activities.
 - a. Coordinate transplanting plant materials that have been salvaged as specified in Section 02237, Plant Salvage, with the Work of this Section.
 - b. Submit methods for coordinating the planting operations with other construction activities to the Program/Project Manager for approval.

B. Sequencing:

1. Documentation of Plant Availability:
 - a. Verify and document the availability of plant materials.
 - 1) Submit written documentation to Program/Project Manager within 30 Days after the award of the Contract for review and approval showing that all plant material is available and secured in a wholesale nursery.
 - a) This verification will serve as proof of availability for all plant material required.
 - 2) Provide the documentation from each nursery supplier supplying plant material on the nursery's letterhead, and include the following information for each nursery item:
 - a) Plant botanical and common name.
 - b) Plant quantities and sizes.
 - c) Nursery name source.
 - d) Contact person.
 - e) Phone number.
 - f) Location of nursery supplier.
2. Documentation of Plant Procurement:
 - a. Verify and document the procurement of plant materials.
 - 1) Submit written documentation to Program/Project Manager within 90 Days of award of the Contract for review and approval showing that all plant material has been procured for the Contract.
 - 2) Provide the documentation from each nursery supplying plant material on the nursery's letterhead, and include the following information for nursery item:
 - a) Plant botanical and common name
 - b) Plant quantities and sizes
 - c) Nursery name
 - d) Contact person
 - e) Phone number
 - f) Location of nursery
3. Include provisions for traffic control during concrete paving operations in the Traffic Control Plan required by MAG Section 401, Traffic Control,



including provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of 7 Days after concrete placement.

- a. Pay particular attention to regulations for the use of cranes or other equipment in the process of tree moving.
- b. Use adequate controls to protect the public and the safety of all involved.

C. Scheduling:

1. Plant Material Delivery Schedule:
 - a. Submit plant material delivery schedules to the Program/Project Manager at least 10 days prior to the intended date of the first delivery.
2. Do not deliver more plant material to the Site than can be planted within 3 days.
3. Proposed Landscaping Work Schedule:
 - a. Prior to the final acceptance inspection described in Subparagraph 3.06.A.3.d, submit a Proposed Landscaping Work Schedule to the Program/Project Manager for approval, and showing operations to be performed by month, including but not limited to the following:
 - 1) Dates of work to be completed.
 - 2) Weed control / herbicide use.
 - 3) Trash and debris pickup.
 - 4) Erosion control.
 - 5) Decomposed granite replacement.
 - 6) Pruning.
 - 7) Pesticide use.
 - 8) Irrigation

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Product Data substantiation that the materials comply with the requirements specified.
 - b. Certificates:
 - 1) Manufacturer's certified analysis of standard products.
 - 2) Certified analysis of non-standard products by a recognized laboratory.
 - 3) Certificates of inspection as required by governmental authorities.
 - c. Special Procedure Submittals:



- 1) Methods for coordinating the planting operations with other construction activities.
- 2) Landscaping Work Schedule.
- d. Qualification Statements:
 - 1) Testing laboratory's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Date Palm (*Phoenix*) Observation Report.
 - b. Site Quality Control Submittals:
 - 1) Date initiating the Plant Establishment Period.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Comply with all local, State, and Federal laws pertaining to the observation, sale, and shipment of plant materials.
2. Dust Control Permit:
 - a. In accordance with Rule 200 of the Maricopa County Air Pollution Control Regulations, a Dust Control Permit issued by the Maricopa County Air Quality Department is required for Sites where more than 0.1 acre (4356 square feet) of soil will be disturbed.
 - b. If a Dust Control Permit is required for this Contract, follow the instructions in the Maricopa County Air Quality Department's "Guidance for Dust Control Permit for Application" and Section 01410, Regulatory Requirements, and file the "Application for Dust Control Permit and Dust Control Plan, and pay the permit fees in accordance with Maricopa County Air Pollution Control Regulation Rule 280.
 - 1) Comply with the requirements of the Maricopa County Dust Control Permit and air pollution control requirements, particularly Maricopa County Air Pollution Control Regulation Rules 310 and 310.01.
 - a) Rule 310 requires maintaining daily logs recording the actual implementation of control measures identified in the Dust Control Permit.
 - c. Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.

B. Qualifications:

1. Testing Laboratory Qualifications:



- a. Employ a recognized independent testing laboratory capable of performing the tests and analysis required in accordance with methods established in the AOAC Official Methods of Analysis of AOAC International.
 - b. Submit the testing laboratory's qualifications to the Program/Project Manager for approval.
 - 2. Arborist Qualifications:
 - a. Employ a licensed Arborist to perform tree branch and root pruning.
 - b. Submit the qualifications of the Arborist to the Program/Project Manager for approval.
 - 3. Pest Control Advisor Qualifications:
 - a. Employ a licensed Pest Control Advisor to recommend and apply herbicide and pesticide controls.
 - b. Submit the qualifications of the Pest Control Advisor to the Program/Project Manager for approval.
- C. Certifications:
- 1. Analysis and Standards:
 - a. For standard products, include the manufacturer's certified analysis of the contents with the package.
 - b. For other materials, submit a certified analysis of the contents performed by a recognized laboratory in accordance with methods established in the AOAC Official Methods of Analysis of AOAC International, wherever applicable.
 - 2. Plant and Planting Material Certifications:
 - a. Submit certificates of inspection as required by governmental authorities.
 - b. Submit other necessary Product Data substantiating that the materials comply with the requirements specified.

1.06 SOIL TESTING

- A. Agronomy Test:
- 1. Prior to planting operations, the contractor shall employ a Certified Agricultural Testing Laboratory to perform agronomy and bioassay tests on the soils where new planting will be performed. An agronomy or bioassay test (5 each) shall be taken at ten (10) locations specified on the plans and as approved by the Resident Engineer. Resident Engineer and The City's Arborist/Horticulturalist may select specific locations for the tests depending on the existing conditions and the potential soil issues.
 - 2. The contractor shall contract with a licensed soils lab to test the soil samples at 1-foot depths at locations mentioned above and as approved by the Resident Engineer of the existing in-situ soil and/or imported soil for use in agricultural fertility analyses.



- a. The soil analyses shall include all characteristics necessary to make fertility recommendations for ornamental landscape, lawn and garden applications.
- b. The report shall include analyses showing PPM of Ca, Mg, Na, K, Fe, Zn, Cu, S, Mn, B, nitrate, nitrogen, and phosphorus at the test locations. The report shall also include levels of salinity, pH, sodium, soluble salts, organic matter percentage, exchangeable sodium percentage, electrical conductivity, and free lime.
- c. The report shall also include recommendations for soil amendments to correct deficiencies, to eliminate conditions detrimental to plant growth, and to improve the soil fertility.

B. Bioassay Test:

1. The soil analysis shall also include Bioassay tests at one-foot depth for the site at previously paved locations mentioned above and as approved by the Resident Engineer.
 - a. Determine any possible toxic chemical contamination of the in-situ soils.
 - b. The soils report shall include recommendations for appropriate mitigation measures should contamination be present.

C. Test Results:

1. Provide the test results and recommendations to the Resident Engineer for review. If, in the opinion of the Resident Engineer, the test results warrant a change in the soil amendments from what is specified, the Resident Engineer will request a proposal for incorporating the additional amendments into the project.
2. Changes to soil amendments from those specified in the specifications will be covered by an adjustment in contract price for the affected items as approved by the Resident Engineer. The costs of the soils testing shall be included in the costs of contracted items. No separate measurement or payment will be made for soil testing.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Review of Plant Material:
 - a. Plants procured are subject to review and approval by the Program/Project Manager for conformance with the requirements specified at the place of growth and/or upon delivery to the Site.
 - 1) For trees having 24 inch and greater box size, the Program/Project Manager will observe and tag the trees in the nurseries.



- a) The Program/Project Manager will tag 10 percent more than the required quantity of trees.
 - b) Clearly designate tagged material by botanical name to ensure that the proper plants will be delivered to the Site.
 - (1) Keep records showing this designation and furnish the records to the Program/Project Manager.
 - 2) Such approval does not limit the right of observation and rejection during the progress of the work.
 - 3) The Program/Project Manager will review the secured, tagged tree quantity and status quarterly to ensure continued availability.
 - b. Observation and tagging of plant material by the Program/Project Manager for design intent purposes does not necessarily constitute the Program/Project Manager's approval of the plant material in regard to their health and vigor as specified herein.
 - c. Request for Review of Plant Material:
 - 1) Submit a written request to the Program/Project Manager for a review of plant materials and quantities at the place of growth.
2. Preparation for Transporting Plants:
- a. Permits and Tags:
 - 1) Obtain the necessary permits and tags for transporting plant materials on public roadways.
 - 2) Make permits and tags available to the Program/Project Manager upon request.
 - b. Prior to shipping, and with care and skill, dig, handle, prepare, and pack the plants for shipment in accordance with recognized standard practice for the kind of plant involved.
 - 1) When temporary storage or heeling-in of plants is required prior to shipping the plant stock, provide and prepare a suitable heeling-in ground or well-ventilated and cool storage shed located near the planting site.
 - c. Boxed Plants:
 - 1) Check plant box containers before moving them.
 - 2) Prior to relocating boxes, repair box damage that may cause harm to the root ball at no increase in Contract Price.
 - a) Repairs include, but are not limited to, providing new bottoms, side reinforcement, re-banding, box repair, or replacement.
 - d. Pre-Transportation of Palms:
 - 1) Water palms thoroughly for 1 week before loading.
 - a) Do not apply anti-transpirants.
 - 2) Prior to shipping palms, reduce the crown and clean the trunks of the palms in accordance with the requirements specified in this Section.
 - a) Remove dead fronds, flower stalks, and seed pods from palm trees, leaving a minimum of fronds beyond the horizontal crown of 6 to 8 tiers of live fronds on each tree.



- b) Tie the crown fronds together loosely, in an upward position to protect the heart of the tree.
 - (1) Tie the fronds with jute or hemp in 2 places.
 - 3) Before palms are loaded, tie small pieces of flagging tape to the newest emerging leaf spear in order to track growth.
 - 4) For lifting and off-loading the palms, a lattice-type, telescoping, or specially designed crane properly sized for the weight of the palm is required.
 - 5) After loading palms, cover the leaves, trunk, and roots with dense shade cloth or other woven material to minimize wind damage.
- 3. Labeling Plants:
 - a. Deliver plants, bundles, and containers of plant material to the Site with a securely attached durable, legible, waterproof tag legibly indicating the plant's name and size in accordance with ANSI Z60.1.
 - 1) Indicate the botanical and common name and size on the label as specified in the plant list.
 - a) In all cases, give precedence to botanical names over common names.
 - 2) Provide data on the landscape material labels substantiating that the plants, trees, shrubs, and planting materials comply with specified requirements.
 - 3) Provide tags for all trademarked plants indicating true species selection.
- 4. Transporting Plants:
 - a. Protect materials from deterioration during shipment and delivery.
 - 1) Ship plants in a manner that will not cause shock or damage to branches, trunks, or root systems.
 - a) Protect branches of plants by tying-in the branches and covering all exposed branches.
 - 2) Furnish vehicles of the size and type suitable for carrying the quantities and sizes of materials shipped without damage to the plants.
 - 3) Pack each species or variety of plant with due regard to shipping conditions and the time to be consumed in transit and delivery.
 - 4) While plants are in transit, protect them against freezing temperatures, sun, wind, and other adverse weather conditions.
 - a) Deliver plant materials to the Site in a protected condition to prevent wind damage and drying.
 - (1) Plants delivered in a wilted condition will be rejected.
 - (2) Do not permit the root systems of the plants to dry out at any time.
 - b) When plants are transported in closed vehicles, provide adequate ventilation to prevent "sweating".



- c) When plants are transported in open vehicles, provide a covering that will allow air to circulate and prevent internal heat from building up.
- b. Transporting Palms:
 - 1) Take complete responsibility for protecting palms during transport.
 - 2) Furnish a trailer for transporting palms that is long enough to avoid damage to the heart of the palm.
 - a) Only use woven nylon slings as securing devices.
 - 3) Minimize movement of palms during transport that might jar or damage the apical meristem.
 - a) Place a nylon choker to maintain proper balance and support.
 - b) Protect the trunk at the points of contact with slings of burlap, canvas, sections of automobile tire casing, or other suitable protective materials.
 - 4) If transporting palms requires over 6 hours, have the driver syringe the leaves and roots with water at 4-hour intervals.
 - 5) If palms are shipped during the summer months, ship them in the evening to minimize rootball drying and sun stress.
- 5. Comply with the regulations applicable to landscape materials.
 - a. Include certificates of inspection required by governing authorities with shipments of landscape materials.
 - b. Provide plants that have been freshly dug at the time of delivery.
 - c. Provide at least one tagged plant in each bundle or lot.
- 6. Provide planting stock declared and certified to be free from disease and insect pests of all kinds.
 - a. Accompany each shipment, invoice, or order of plants with all necessary inspection certificates, and give them to the Program/Project Manager upon arrival at the point of delivery.
- 7. Deliver trees and shrubs after preparations for planting have been completed, and plant them immediately.
 - a. Do not prune trees and shrubs prior to delivery unless otherwise approved by Program/Project Manager.
 - b. Prior to digging evergreen trees, apply anti-transpirant to the trees.
 - c. Provide protective covering for trees and shrubs during shipment.
 - d. Do not drop balled and burlapped stock during delivery or handling.
 - e. Do not bend or bind-tie trees or shrubs in such manner as to damage their bark, break their branches, or destroy their natural shape.
- 8. Deliver packaged materials in unopened containers showing the weight, analysis, and name of its manufacturer.
 - a. Deliver commercial fertilizer to the Site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis.
- 9. Acceptance at the Site:
 - a. General Plant Health and Condition:



- 1) Provide plants in a healthy condition with normal symmetrical form; developed foliage, branches, and cane systems; and free from broken tops.
 - a) Plant material exhibiting a heated or sweated condition due to tight packing or poor ventilation is subject to rejection.
 - b) Any plants furnished with fine hair roots omitted, or with main roots cut, will be immediately rejected.
 - c) Provide plants, including their roots, free from scale, knots, sunscald, injuries, abrasions, disfigurements, disease, insect eggs, and infestations or any other injurious qualities.
 - (1) If any small wounds are on the plants, they must have satisfactory callus roll formed or forming over them.
 - d) Provide plants that show good annual growth.
 - e) Provide plants with plump and well filled buds for the species.
 - f) Provide plants with evergreen foliage of a good intense color.
- 2) Trees:
 - a) Provide well branched trees, with grafts at ground level and with trunks throughout their full height.
 - b) Trees with weak, thin trunks incapable of supporting themselves when planted are unacceptable.
- 3) Date Palms:
 - a) Have a qualified palm specialist or palm plant pathologist observe all Date Palms (*Phoenix*) before the palms are dug up and moved.
 - (1) Submit a Date Palm (*Phoenix*) Observation Report from the qualified palm specialist or palm plant pathologist to Program/Project Manager for information.
 - b) Final approval of the overall appearance of the Date Palms is the responsibility of the Program/Project Manager.
 - c) Date Palms (*Phoenix*) may be rejected if they are found to have been pruned within 5 months prior to observation.
- 4) Container Stock:
 - a) Provide container stock free of root bind and having sufficient roots to hold the rootball intact after removal from the container.
 - b) Provide Saguaro with sufficient roots to ensure a structurally sound foundation to sustain the cactus in its vertical position while encountering winds up to 40 miles per hour and/or under wet soil conditions.
 - (1) Mark the north-facing side.
- 5) "B and B" Plants:
 - a) "B and B" plants arriving with broken or loose balls, or having "manufactured" earth in lieu of the original and undisturbed soil in which the plant grew will be rejected.
- 6) Tagged Material Records:



- a) Submit copies of records showing that selected plant materials were delivered to the Site to the Program/Project Manager.

B. Storage and Handling Requirements:

1. Take sole responsibility for the health and vigor of the plant material.
2. Unloading Palms:
 - a. Gently lift palms off the transport, setting the choker to the outside to turn the palm to the inside as it is lifted.
 - 1) Use only 6 inch nylon chokers.
 - b. Do not bend, shake, drop, pull on, or otherwise damage the palm bud or heart.
3. Handling Plant Material:
 - a. Handle each species or variety of plant in an approved manner as required by soil and climatic conditions at the time of digging.
 - b. Do not drop or handle plants by their foliage, branches, or trunks.
 - c. Handle container plants only by the container.
 - d. When placing the plants by using a crane, lift the containers using a nylon strap to protect the trunk and stems from damage.
 - 1) Do not use chains for lifting.
 - e. Handling of Palms:
 - 1) Minimize lifting or handling palms by the trunk.
 - 2) Use only a 6 inch wide nylon sling when moving or lifting palms.
 - a) Never bind or handle palms with wire, chains, or rope.
 - 3) Do not stack palms.
4. Temporary Plant Storage:
 - a. If accepted planting stock is not planted immediately, properly heel-in or store it.
 - 1) Stock left out of the ground and unprotected overnight, left with roots exposed to heat or freezing, or otherwise unprotected during transit, unloading, heeling-in, or planting will be rejected.
 - 2) Do not remove container-grown stock from containers until planting time.
 - b. Store plant materials where they are protected against damage and dehydration until planted.
 - c. If planting is delayed more than 6 hours after their delivery, set trees and shrubs in the shade, protect them from weather and mechanical damage, and keep their roots moist by covering them with mulch, burlap, or other acceptable means of retaining moisture.
 - 1) Provide shade for sun-sensitive plants.
 - d. Take complete responsibility for protecting palms during storage.
 - 1) Plant palms immediately upon arrival, or store them for no more than 3 to 4 days in a shaded area where the entire tree can be misted and burlapped.
 - a) Do not allow the palm tree to lay in the sun or on asphalt.



5. Pesticides and Herbicides:

- a. Periodically verify the current status, and the delivery, storage, handling, and transporting requirements of pesticides and herbicides used.

1.08 SITE CONDITIONS

A. Ambient Conditions:

1. Perform planting operations only when weather and soil conditions permit, and in accordance with locally accepted practices.
 - a. Unsuitable conditions include moisture saturated or frozen in place soil, and precipitation of any kind present or occurring during the Work.
 - b. When drought, excessive moisture, or other unsatisfactory conditions prevail, stop work when directed by the Program/Project Manager.
2. Planting Times and Conditions:
 - a. The Work of this Section may include dormant or cold weather planting procedures for appropriate species, including staking plant materials and installing protective mulch on plant pit locations.
 - 1) Plant dormant deciduous trees suitable for such seasonal operations, in order that landscaping can be in place at the earliest possible time.
 - b. If special conditions warrant a variance to the planting operations, submit proposed planting times to the Program/Project Manager and obtain an approval of the variance in writing.
 - c. Plant field-grown trees in the same growing season in which they were dug.

B. Existing Conditions:

1. Plant quantities shown in the planting schedule on the Contract Drawings are for general reference only.
2. Determine the actual plant quantities and materials necessary to complete the Work in accordance with the symbols shown on the Contract Drawings.

1.09 WARRANTY

A. Special Warranty:

1. Warrant trees and shrubs for a period of one year after the date of acceptance or until the Plant Maintenance Period specified in Paragraph 3.10.A ends, whichever is later, against defects.
 - a. The date of acceptance is defined as the date for the inspection requested by the Contractor after the last planting is installed and mulched, and at which time all conditions are acceptable to the Owner and the Program/Project Manager.



- 1) Irrigation record drawings must be approved.
- 2) Pre-maintenance observation punch list items must be completed and approved by the Program/Project Manager.
- b. Although periodic requests for payment will be accepted, their individual approval and subsequent payment does not activate the warranty period until all plants are in place and inspected by the Owner and the Program/Project Manager.
- c. Defects include death and unsatisfactory growth, except for defects resulting from neglect by the Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Contractor's control.
2. Provide a warranty that does not limit plant replacement to "one time"; replace plants as many times as necessary in a single location until acceptance.
3. Replacement Plants:
 - a. All replacement plants provided under the warranty must be approved by the Program/Project Manager at the source prior to planting.
 - b. Provide a 100 percent guarantee for all replacement plants.
 - c. Plant the replacement plants per the provisions of this Section.
 - d. The Contractor is not responsible for plant loss or damage caused by unusually extreme weather, vandalism, or lack of maintenance by the Owner.
4. If the Warranty Period extends beyond the plant establishment/maintenance period, check the landscaping at least once every 2 weeks during the Warranty Period, and submit any advised changes in writing to the Program/Project Manager.
5. Submit the warranty in writing as part of the closeout submittals.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

- A. Under no circumstances will substitutions for plants or sizes listed on the Contract Drawings be allowed, except with the express approval of and as directed by the Program/Project Manager.
1. The Program/Project Manager will consider plants of other kinds than those indicated on the planting schedule only upon submission of proof that the specified plant is not reasonably procurable in the local region. Proof shall be considered contacting a minimum of five (5) nurseries for availability.
 - a. Request proposed substitutions due to unavailability in writing for approval by the Program/Project Manager prior to confirming the order.
 - b. Should plant materials not be secured, and materials become unavailable at the time of installation, install a larger container size of an equal plant variety at no increase in Contract Price.



2. Plants larger than specified in the planting schedule may be used if approved by the Program/Project Manager and provided at no increase in Contract Price.
 - a. If the use of larger plants is approved, increase the root ball in proportion to the size of the plant.
- B. Replacement plants will be approved based on their resemblance to the plant specified in regard to appearance, ultimate height, shape, habit of growth, and general soil and other requirements.
- C. In no case may the average cost and value of the substituted plants be less than the cost and value of plants indicated.

2.02 DESIGN CRITERIA

- A. Provide materials and perform the work of this Section to comply with the requirements of those industry standards cited, except as may be amended herein.
- B. Plant Types and Names:
 1. Provide plants true to type and name in accordance with the latest edition of AJCHN Standardized Plant Names nomenclature.
 - a. Properly label each plant with its type and name.
 - 1) Where a formal arrangement or consecutive order of trees or shrubs are shown on the Contract Drawings, select stock for uniform height and spread, and label it with numbers to assure symmetry in planting.
 - b. Provide the quantity of trees, shrubs, and plants of the size, genus, species, and variety shown and scheduled for landscape work in the planting schedule specified in Subparagraph 1.07.B.1 and that complies with the recommendations and requirements of ANSI Z60.1 and recognized horticultural sources.
- C. Species, Sizes, Grades, and Condition:
 1. Refer to the planting schedule on the Contract Drawings for the species and size of plants required.
 - a. Requirements for measurements, branching, and quality of plants in the planting schedule generally follow the code of standards currently recommended by the American Association of Nurserymen, Inc. in ANSI 260.1, or in accordance with City standards.
 2. Minimum Acceptable Plant Sizes:
 - a. Provide plants of sizes conforming to the measurements indicated on the Contract Drawings or specified.
 - 1) Measure plants before pruning with the branches in normal position.



- 2) Plants larger in size than indicated may be used if acceptable to the Program/Project Manager and if the sizes of root balls are increased proportionately, but at no increase in Contract Price.
 - a) If larger plants are used, proportionately increase the root ball or spread of roots in accordance with ANSI Z60.1 rules.
- b. Provide plants of a size corresponding to that normally expected for the species and variety of commercially available nursery stock as specified on the Contract Drawings.
 - 1) Plants are subject to certain variations in size and measurement if specified on the Contract Drawings.
 - 2) Provide plants equal to or exceeding the measurements specified in the Plant List, which are minimum acceptable sizes.
 - 3) Plants must be measured before pruning, with branches in normal position.
 - 4) For plants used in a group or in close proximity, provide plants of the same variety and of uniform size.
- c. Do not prune, trim, or top tree or plant materials prior to delivery; and only alter their shape with the approval of and as directed by the Program/Project Manager.
 - 1) Street trees require 7 feet of clearance over pedestrian areas.
 - 2) Prune plants as approved by the Program/Project Manager.
- d. Trees:
 - 1) The height of branching must bear a relationship to the size and variety of the tree specified, and the crown must be in good balance with the trunk and trunk caliper.
 - 2) Do not provide "poled" trees or remove the leader.
 - 3) Single-trunk plants must be reasonably straight and symmetrical with the crown according to species and have a persistent main leader.
 - 4) Dig and box boxed trees at least 90 days prior to planting.
 - 5) Provide trees for groves that match in caliper, height, spread, and overall form.
 - 6) For palm trunks that are to be matched in height, measure the trunk from the top of the rootball to the edge of the brown trunk.
 - 7) The minimum palm rootball size is 5 feet by 5 feet by 5 feet with a flat bottom.
 - 8) Provide date palms (*Phoenix*) having diamond cut that provides a clean consistent appearance.
3. Unless otherwise specified, provide Grade No. 1 plants in accordance with ANSI Z60.1.
4. Provide plants that have a normal habit of growth and that are sound, healthy, vigorous, and free of fresh bark abrasions, excessive abrasions, and other objectionable disfigurements.

D. Plant Source and Condition:



1. Provide nursery-grown stock unless otherwise indicated or specified.
 - a. Provide plants complying with the Arizona State Department of Agriculture regulations for nursery observations, rules, and ratings.
 - b. Provide healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, injurious insects, eggs, larvae, and defects such as mechanical wounds, broken branches, decay, knots, sun-scald, injuries, abrasions, disfigurement, or any other defect.
 - c. Provide plants that have been growing in a climate comparable to that of the Site for at least 2 years.
 2. Provide freshly dug trees and shrubs.
 3. Provide plants having well-branched, vigorous, and balanced root and top growth.
 4. Provide deciduous trees having straight trunks with well-branched tops and a single leader.
 5. Provide plants, including their containers, free of noxious weeds including Bermuda, Johnson, and nut grasses.
 - a. Containerize salvaged plants as specified in Section 02237, Plant Salvage.
- E. Plant Acclimation:
1. Acclimate plant material to the Arizona environs for not less than 8 months prior to planting.
 - a. Any off-site storage arrangement must meet this acclimation requirement.
 2. Make materials stored for acclimation available for periodic review by the Program/Project Manager.

2.03 MATERIALS

- A. Ocotillo:
1. Provide Ocotillo in good condition with bark free of abrasions, rotting, or other damage.
 2. Provide well branched Ocotillo plants.
 3. Provide Ocotillo having a 24" box diameter root mass.
 - a. For container grown ocotillo, the plant must be well rooted in the container.
 - b. For bare rooted ocotillo, the plant must have a healthy, developed root system suitable for bare root planting.
- B. Palms:
1. Geneses: Date Palms (*Phoenix*), California Fan Palms (*Washingtonia robusta*), and Mexican Fan Palms (*Washingtonia filifera*).
 2. 30 days prior to digging *Washingtonia* palms, skin a maximum of 60 percent of the trunk measuring from soil line.



- a. Prevent the spread of vascular disease and minimize wounding by tools in sterilizing agent before skinning or pruning palms, and moving from one palm to another.
 3. For digging palm root systems, use either a trenching machine or a backhoe having a narrow bucket.
- C. "B and B" and Container-Grown Plants:
 1. If plants are designated herein or on the Contract Drawings as "B and B", provide balled and burlapped plants as follows:
 - a. Form a ball from the original and undisturbed soil in which the plant grew.
 - b. Wrap the ball with burlap or similar approved material, and tightly lace it to hold the ball firm and intact.
 - c. Provide "B and B" plants having a ball diameter and depth in accordance with ANSI Z60.1 and sufficiently large to include the necessary root system.
 2. When containers are indicated or specified, furnish and plant the plants in approved decomposable containers if possible or unless otherwise specified.
 - a. Remove non-decomposable containers as the plant is placed in the ground.
 3. Provide containers sufficiently rigid to hold the ball shape and protect the root mass during shipping.
 4. Grow plants in pots, cans, tubs, or boxes for a minimum of 3 months and a maximum of 1 year without root bind before delivery.
 5. Provide container stock having sufficient roots to hold the soil intact when the plant is removed from the container.
 6. Insure that containers are free from noxious weeds including Bermuda grass.

2.04 ACCESSORIES

- A. Anti-Transpirant:
 1. Provide an organic, non-toxic, biodegradable anti- transpirant spray that forms a clear, protective coating on foliage to help plants retain moisture.
 2. Manufacturers:
 - a. Wilt-Pruf Products, Inc., www.wiltpruf.com.
 - b. Approved equal.
- B. Backfill:
 1. Provide backfill for trees, shrubs, and root pruning trenches as indicated on the Contract Documents.
- C. Backfill mix:



1. Provide backfill mix consisting of 4 parts topsoil, 1 part sand, and 1 part stabilized organic matter for each cubic yard of topsoil.
 2. Mix the backfill mix in bulk in a preparation area, and do not individually place and mix it within the plant pits.
 3. For date palms, the backfill mix shall be 100 percent clean washed concrete sand.
- D. Decomposed Granite 1/2" Minus Madison Gold:
1. Provide 1/2" Minus decomposed granite Madison Gold in color throughout, and having the following material size gradation using standard sieve sizes:
 - a. 100 percent passing the 1-1/2-inch sieve.
 - b. 100 percent passing the 1-inch sieve
 - c. 82 percent passing the 1/2-inch sieve.
 - d. 51 percent passing the Number 4 sieve.
- E. Guy Stakes:
1. Provide wooden guy stakes, free of knots or other structural defects that would cause breakage while the stake is being pounded into place.
 - a. Dimensions, Minimum: 2 inches by 2 inches by 8 feet in length.
- F. Guy Wire:
1. For guying plants as shown in the Contract Drawings, provide 12 gage minimum, multi-stranded, galvanized steel wire covered with rubber hose where it would otherwise come into contact with the plant.
- G. Gypsum:
1. Provide gypsum as commercially available for planting uses.
- H. Pesticides/Herbicides Treatment Applications:
1. Provide the types of insecticides or herbicides and use methods of application conforming to Environmental Protection Agency, state, and local requirements and labeling instructions.
 2. Only use insecticides or herbicides approved by the Program/Project Manager.
 - a. Notify the Program/Project Manager and obtain prior approval for the use of any chemicals for insect eradication or control and weed eradication or control.
 3. Herbicides:
 - a. Provide weed control as approved by the Licensed Pest Control Advisor.
 - b. Pre-emergent herbicide:
 - 1) Provide pre-emergent surface-applied herbicide capable of providing control of key grasses and broadleaf weeds.
 - 2) Manufacturers:



- a) United Phosphorus, Inc., Surflan® pre-emergent herbicide, www.upi-usa.com.
 - b) Approved equal.
 - c. Post-emergent herbicide:
 - 1) Provide post-emergent herbicide designed for aquatic use with no restrictions on water use, specifically domestic use, after application.
 - 2) Manufacturers:
 - a) Dow AgroSciences LLC, Rodeo®, www.dowagro.com.
 - b) Approved equal.
- I. Mulch:
 - 1. Plant Mulch:
 - a. Provide wood cellulose fiber mulch free from foreign material and substances toxic to plant growth and having the following properties.
 - 1) Acid reaction: 4 to 5 of that of shredded oak tree bark.
 - 2) Moisture Content: 15 to 40 percent natural.
 - 3) Particle Size: In the range from 1/2-inch to 2-inch diameter.
 - 4) Grade: Processors Number 1.
 - 5) Carbon to Nitrogen Ratio 20:1 or less.
- J. Topsoil:
 - 1. Provide topsoil in accordance with the requirements of Section 02919, Topsoil.
- K. Water:
 - 1. Provide and transport water for planting operations.
 - a. Provide water that is free of oil, acid, salts, and other toxic elements.
 - b. The water source must be approved by the Program/Project Manager prior to use.

2.05 SOURCE QUALITY CONTROL

- A. Inspections:
 - 1. The Program/Project Manager may inspect trees and shrubs either at the place of growth or at the Site before planting for compliance with the requirements for genus, species, variety, size, and quality.
 - a. The Program/Project Manager has the right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during the progress of the Work.
 - 2. Inform the Program/Project Manager of the source of supply for plant material for this Contract so that he has the opportunity to select the materials at the source.



- a. Not less than 14 days prior to installing plantings, submit complete and detailed information concerning the source of supply for each item of plant material on the planting schedule that appears on the Contract Drawings.
 - b. Make all planting stock available for inspection in the nursery before it is dug.
- 3. Do not make substitutions:
 - a. If specified landscape material is not obtainable, submit proof of non-availability to the Program/Project Manager, together with a proposal for the use of equivalent material.
- B. Non-Conforming Work:
 - 1. The Program/Project Manager is the sole judge of the acceptability of the plant material.
 - 2. Defective Materials:
 - a. Any plant not conforming to the requirements herein is considered to be defective.
 - b. Mark all defective plants, whether or not in place, as rejected; and immediately remove them from the Site, and replace them with new plants additional increase in Contract Price.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Investigate field conditions and be familiar with the Site.
 - a. Verify that trenches, foundation backfill, or other filled excavations are compacted prior to beginning landscape Work.
 - b. Verify that planting areas are free of any waste or debris.
 - 2. Verify that final grades within plus or minus 0.10 foot of the design elevation have been established prior to commencing landscaping operations.
 - a. Allow for inclusion of amendments, settling, and similar conditions.
 - b. Verify that surface drainage is away from building foundations and wall, and will ensure proper drainage of the Site as indicated on the Contract Drawings.
 - c. Advise Program/Project Manager of discrepancies in grade between the Contract Drawings and actual Site conditions.
- B. Evaluation and Assessment:
 - 1. Determine the requirements for preparation and construction methods appropriate to the soil type, weather conditions, and Site anomalies.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain the grade stakes until it is mutually agreed to by the parties concerned to remove them.
 - 2. Underground Obstructions to Planting:
 - a. Prior to any landscape operations, locate and protect all existing underground installations in landscaping areas.
 - 1) Verify the location of underground utilities and facilities through Arizona Blue Stake.
 - a) Determine the location of underground utilities and mark the locations with stakes or flags.
 - b) Perform the Work of this Section in a manner that avoids damaging in-place utilities.
 - (1) Hand excavate as required.
 - 2) Report any conflicts or discrepancies identified to the Program/Project Manager, and do not start landscaping operations until the discrepancies are corrected.
 - 3) Whenever excavating holes for proposed/existing palm/tree removal/installation in close proximity to utility duct bank facilities, direct the landscape Subcontractor to hand dig the bottom 2 feet of the hole.
 - a) Excavate a 4-foot by 4-foot by 4-foot hole for each palm or tree.
 - 3. Temporary Tree and Plant Protection:
 - a. Identify, protect, and maintain existing vegetation within protected areas in accordance with the requirements of Section 01568, Temporary Tree and Plant Protection, for the duration of the Contract.
 - 4. Provide temporary erosion control and sediment controls in accordance with the requirements of ADEQ and AZPDES requirements.
 - 5. Protective Fencing:
 - a. Prior to the start of construction activities on the Site, define the limits and boundaries of the areas designated as off-limits.
 - b. Provide protective fencing as noted on the Contract Drawings and in accordance with Section 01568, Temporary Tree and Plant Protection, for existing landscaped plants and preserve-in-place vegetation to protect them from construction activities.
 - c. Provide temporary fencing in accordance with Section 01500, Temporary Facilities and Controls, to adequately protect workers, the general public, and existing features and structures from construction activities.
 - 6. "Preserve In Place" Plant Materials:
 - a. Maintain all "preserve in place" plants as designated on the Contract Drawings.
 - b. Provide an adequate water supply to any "preserve in place" plants affected by construction activities.



B. Surface Preparation:

1. Weed Control:

- a. If live perennial weeds exist on the Site at the beginning of the landscaping operation, employ an Arizona licensed pesticide applicator to spray those weeds with contact herbicide according to the manufacturer's instructions.
 - 1) Submit a pesticides/herbicides record that includes the following:
 - a) Pesticides/herbicides applications dates and locations.
 - b) Types of insecticides or herbicides used, both pre- and post-emergent.
 - c) Trade names, chemical composition, formulation, concentration, and application rates of active ingredients.
 - d) Methods of application.
 - e) Name and state license number of applicator.
- b. After allowance of adequate time for systemic weed kill, clear and remove the dead vegetation; and use mechanical, manual, and/or chemical treatment to maintain the entire Site weed-free until Final Acceptance by the Program/Project Manager.
 - 1) Remove all weeds, including Bermuda Grass, Johnson Grass, Buffle Grass and Nut Grass; and dispose of the weeds off-site in a legal disposal area.

2. Layout of Planting Areas:

- a. Prior to grading, paint, stake, or flag the layout of berm locations for approval by the Program/Project Manager.
- b. Shape planting areas as indicated or directed by Program/Project Manager.

3. Grading:

- a. Grade the planting areas to a smooth, even, and uniform plane with no abrupt changes to surface.
 - 1) Make minor grade modifications required to establish the final grade.
 - 2) Grade the planting areas so finish grades are plus or minus 1 inch below adjacent paved areas, sidewalks, valve boxes, headers, clean-outs, manholes, and similar structures, or as indicated in the details on the Contract Drawings.
- b. Level the planting areas to properly float water for even distribution of irrigation water.
- c. Dispose of any unacceptable or excess soil or other materials at a legal off-site disposal area, and pay the dumping fees and charges.
 - 1) Remove soil generated by excavations to a legal, off-site location unless the soil can be used to obtain required grades.

4. Moisture Content:

- a. Do not work the soil when the moisture content is so great that excessive compaction will occur, or when the soil is so dry that dust that dust will form in the air or clods will not break readily.



- b. Apply water as required to obtain ideal moisture levels for backfilling and for planting as specified.
- 5. Layout of Plant Materials:
 - a. Lay out the planting areas and flag the plant locations in reasonably close conformity to the dimensions and locations shown on the Contract Drawings.
 - b. Relocate planting areas or make other modifications at this time to avoid utility lines and impervious or wet soil conditions.
 - c. The Program/Project Manager will check the layout and flagging of the planting areas prior to the start of the installation of the irrigation system.
- 6. Soil Preparation:
 - a. After removing any extraneous materials but prior to installing the irrigation system, till the soil to a depth of 12 inches .
 - b. Where access by large machines is limited, use a rototiller to break up the soil.
 - c. Level the soil by raking only; do not compact the soil.
 - d. Disk or till sloped areas along the contour.
 - e. Leave the surface rough.
- C. Demolition/Removal:
 - 1. When conditions detrimental to plant growth, such as rubble fill, adverse drainage conditions, or obstructions, are encountered during excavation notify the Program/Project Manager and obtain direction before planting.
 - 2. Remove any rock and other underground obstructions, if possible, to the depth necessary to permit proper planting according to the Contract Drawings and as specified.
 - 3. Excavate and remove any subsurface obstructions, materials, or substances which conflict with or impact the installation of plants or may be detrimental to plant health to a minimum of 2 times the root ball container depth and 4 times the root ball container width.
 - 4. If underground construction, obstructions, or rock are encountered within excavations for planting areas, other locations for the plantings may be selected only with the approval of the Program/Project Manager.

3.03 EXCAVATION FOR PLANTING

- A. Prior to any excavation for planting pits, trenches, beds, or irrigation, obtain the Program/Project Manager's approval of all planting areas and locations.
- B. Shrub Bed Preparation:
 - 1. For the shrub masses shown on the Contract Drawings, provide a continuous bed for each mass planting.



- a. Strip the bed of turf, and cultivate the entire area by incorporating peat and any required soil supplements into the top 6 inches of the existing topsoil.
 - 1) Cultivate the area by rototilling or plowing and discing so that the entire surface is tilled.
- b. Incorporate a quantity of peat into the topsoil equal to 3 inches of peat spread uniformly over the plant bed.
- c. For shrub, ground cover, and other planting beds in areas where extensive weed elimination is necessary, take the following additional measures to prepare the beds prior to disturbing the planting bed areas:
 - 1) Apply a pre-emergent herbicide to the areas per the herbicide manufacturer's instructions.
 - a) Take care to assure the pre-emergent herbicide is placed only in the area of the plant bed.
 - 2) Apply a frill or injection method application of a post-emergent herbicide to woody vegetation of a size larger than 1-inch caliper per the herbicide manufacturer's instructions.
 - a) Apply this to all woody stumps remaining from previous clearing and grubbing operations.
 - b) Paint the frill application on a fresh cut stump area.
 - 3) Apply a spray application of a post-emergent herbicide to the proposed plant bed area per manufacturer's instructions.
 - a) Take care so that overspray does not extend beyond the bed areas.
 - b) Verify that plants to be eliminated are in an active growing state prior to applying the spray.
 - 4) After a 7-Day waiting period, determine if a repeat application of the post-emergent herbicide is required.
 - a) If weeds and the existence of vegetation in the area of the plant bed are evident, apply a second application.
 - 5) After a 7-Day waiting period beyond the final post-emergent herbicide application, dig out woody plant stumps larger than 1 inch caliper, including the roots, and dispose of them off-site.
 - 6) Remove any existing vegetation not killed by the herbicide application by hand digging, and removed it off-site.
 - 7) Cultivate the beds as specified in Subparagraphs 3.03.B.1.a and 3.03.B.1.b.
- C. Planting Bed, Plant Trench, and Plant Pit Preparation:
 - 1. Plan digging operations, particularly those on slopes, so actual planting operations will follow within 24 hours.
 - 2. Prepare planting beds, plant trenches, and plant pits to the depths required below finished grade according to the recommended practices of ANSI Z60.1.



3. Excavate plant pits with vertical sides and flat bottoms.
 - a. Construct plant pit diameters at least two and half times the diameter of the plant root ball with at least 6 inches of open excavation between the root ball and the vertical wall of the pit in all directions.
 - b. Refer to the planting details on the Contract Drawings for further information.
4. In pits for larger plants, such as for deciduous shade trees and evergreens, provide sufficient depth to allow placing the root ball on the subgrade prior to backfilling.
 - a. Percolation Test:
 - 1) Prior to planting any trees, determine if there is a problem drainage condition by running a percolation test on the tree pits as follows:
 - a) Fill the planting pit 1/2 full of water.
 - b) Allow 24 hours for the pit to drain.
 - c) If the pit has not substantially drained after 24 hours, install a caisson as specified in Subparagraph 3.03.C.4.c.
 - b. Construct plant pit diameters at least two and half times the diameter of the plant root ball with at least 12 inches of open excavation between the root ball and the vertical wall of the pit in all directions.
 - c. Caisson Installation:
 - 1) For trees greater than a 24 inch box size, drill a 5 feet deep by 8 inch diameter caisson in the bottom of the pit.
 - 2) Fill the caisson with 1-1/2 inch crushed stone up to the bottom of the pit.
 - 3) Adjust the depth of the caisson if ground water or caliche is encountered.
 - d. Refer to the planting details on the Contract Drawings for further information.
 5. Container Stock Plant Pits:
 - a. Provide approximately circular plant pits with a diameter 3 times the width and a depth at least the height of the plant ball or container.
 - 1) If the pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface.
 - 2) Provide pits large enough to permit handling and planting without injury or breakage of the root ball or root system.
 - b. If soil is added to level or stabilize the plant, compact the soil to avoid settlement after planting.
 - c. Do not allow plants to stand in these pits without watering.
 6. Boxed Tree Planting Pits:
 - a. Boxed material must be observed and approved by the Program/Project Manager prior to planting it in a new location as shown on the Contract Drawings.
 - b. Provide planting pits with a minimum of 3 times the width of the box size and a depth the same as the depth of the box size, or as large as



- necessary for placing the tree in the pit without damage to the tree, adjacent structures, or existing landscaping.
- c. Conduct the soil percolation test as specified in Subparagraph 3.03.C.4.a.
7. Palm Planting Pits:
- a. Provide palm planting pit the same depth and twice the width as the rootball.
 - b. Conduct the soil percolation test as specified in Subparagraph 3.03.C.4.a.
- D. Work Under or Near Existing Vegetation:
- 1. Where landscape operations occur below the canopy spread of existing trees, perform the work by hand or other methods as necessary to complete the Work and prevent damage to any limbs, branches, trunks, or roots.
 - a. Field verify the location or route that will provide the least disturbance of the root structure.
 - b. When roots 2 inches or larger in diameter are encountered, tunnel or excavate under or around them and protect them from any damage.
 - c. When roots less than 2 inches in diameter are encountered, cleanly prune and paint them with 2 coats of standard tree paint or compound prior to backfilling.
 - d. Do not leave roots unprotected from damage caused by exposure or loss of moisture.
 - 2. Complete excavation or trenching below existing trees that are shown to remain by staying the greatest allowable distance away from the trunk and limiting work to one side of the tree.
 - 3. Notify the Program/Project Manager for direction if conditions are encountered which may affect trees or landscape installation methods.

3.04 PLANTING

- A. Plant trees and shrubs after the final grades are established and prior to the planting of lawns unless otherwise acceptable to Program/Project Manager.
- 1. If the planting of trees and shrubs is to occur after lawn work, protect the lawn areas and promptly repair damage to lawns resulting from planting operations.
- B. Plant Setting Operations:
- 1. Perform planting operations in conformance with planting details shown on the applicable Contract Drawings.
 - 2. Set plants plumb and straight with allowance for settlement and in accordance with following:
 - a. Set plants to ensure that after settlement the plant stem projects from the soil as much as before transplanting.



- b. Set plants no shallower or deeper than they stood in the nursery, and excavate pits as specified in Paragraph 3.03.C to the correct depth to set the plants at their proper height.
- 3. Shrubs:
 - a. Unless directed otherwise by the Program/Project Manager, place shrub as far from foundations, fences, walls, and walks as the character of growth demands, but in any event no closer than 20 inches.
- 4. Trees, Yuccas, and Saguaros:
 - a. Do not place trees, yuccas, and saguaros closer than 6 feet to foundations, fences, walls, and walks unless directed otherwise by the Program/Project Manager.
 - b. Set trees, yuccas, and saguaros plumb and rigidly brace them in position until the soil has been tamped solidly around the ball.
- 5. Container Stock:
 - a. Completely remove containers from potted plants; however, keep the earth unbroken around roots.
 - b. After removing the plant from the container, scarify the side of the root ball to eliminate any root bound condition.
 - 1) Do not plant the stock if the root ball is cracked or broken.
 - c. Handle balled and burlapped plants by the earth ball, and not by the plant itself.
 - d. Unless otherwise specified, place all plants in the center of planting pits with the plant upright, and face the plant to give the best appearance and relationship to the adjacent plants or structures.
 - e. Set each plant in prepared circular pits deep enough to accommodate a bed of topsoil not less than 6 inches deep under the ball or pot of shrubs and 12 inches under the ball of trees.
 - 1) After placing balled and burlapped plants in their pits without removing the burlap, lay the burlap back from the ball.
 - 2) Remove burlap from the top third of root balls, and completely remove ropes, twine, and wires from root balls.
 - f. Set the plants in relation to the surrounding grade so they are even with the depth at which they were grown in the nursery or container.
 - g. Place backfill mix in plant pits under and around root balls in 6-inch layers and tamp it to eliminate voids.
 - 1) At the halfway point in backfilling, flood the pit with water and continue backfilling after the water dissipates.
 - a) Place a 2-inch layer of plant mulch within the ring prior to watering.
 - 2) Backfill pits to grade, and build up a ring of soil 3 inches deep over the edge of the plant pit to facilitate maintenance watering.
- 6. Boxed Trees, Yuccas, Saguaros, and Palms:



- a. Notify the Program/Project Manager at least 2 days in advance of planting boxed trees, yuccas, saguaros, and palms to obtain approval of the equipment to be used for planting.
 - 1) The Program/Project Manager must also be present at the time the trees, yuccas, saguaros, and palms are set and positioned in the planting pit.
- b. Fill the excavated planting pits half way with water, and allow them to drain before placing the trees in the pits.
 - 1) Any drainage problem must be rectified prior to planting the tree.
- c. Carefully lower the boxed trees, yuccas, saguaros, and palms into their pits using approved equipment, and at no time push or drop them into the pit.
 - 1) Position boxed trees 30 inches or greater, saguaros greater than 6 inches, and all palms by crane.
 - 2) Position the top of the root ball 1 inch above the adjacent finish grade.
- d. Do not damage branches and root balls.
- e. Add soil backfill under the tree or sand under the palm, yucca, or saguaro if needed to bring the root ball to the proper height.
 - 1) Plant saguaros and yuccas to their original depth.
- 7. Setting Bare Root Plants:
 - a. Set bare root plants with the root system properly spread out, and work backfill mix in among the roots.
 - b. Cleanly cut off any broken or frayed roots.
 - c. Backfill the bare root plants to grade in 6-inch layers using water to settle each layer.
 - d. Form a ring of soil 3 inches deep over the edge of each plant pit to facilitate maintenance watering.
- C. Planting Ground Cover, Bulbs, and Perennials:
 - 1. Till plant beds for perennials to a minimum depth of 8 inches and amend the beds with 1 part soil amendment per 4 parts topsoil.
 - 2. Setting Ground Cover Plants:
 - a. Set each plant in a slight depression for catching rainwater, and top-off such depressions with 2 inches of mulch spread uniformly and compacted.
 - b. Thoroughly water the ground cover bed immediately following planting.
- D. Palm Planting
 - 1. Palm trees shall not be planted until the irrigation system is installed, functioning and has been approved by the Engineer.
 - 2. Layout palms of locations shown on the plans. Use 3 foot lath, color coded for each palm height. The Engineer will check and approve location of palms in the field prior to any planting operations



3. The palm tree excavation shall be a minimum of the depth of the root ball and twice the diameter of the root ball. Palm planting pits shall be reviewed and approved by the Engineer.
 4. Palms shall not be planted any deeper than one (1) foot above the soil line of the palm trees original finish grade line. If the existing finish grade line is not obvious or visual contractor shall mark line with pruning paint or other acceptable method no wider than 1/2" at base of palm trunk to provide reference during planting operations.
- E. Immediately after plant setting and prior to watering, evenly apply mulch over planting areas not more than 3 inches deep.
- F. Backfilling:
1. Planting areas are considered to have sufficient topsoil for preparing beds; however, furnish and place the topsoil required within each plant pit for the backfill mix.
 - a. Place the backfill in 6-inch increments of depth.
 - b. Work the backfill mix around plant balls in the pits and firmly tamp and/or puddle it as backfilling progresses
 - c. Fill voids in order to eliminate air pockets.
 - d. If necessary, and always in the case of shade trees, hold each plant in a vertical position while the backfill soil is being placed.
 - e. Remove sticks, sod, clods, or other material that could decompose and form air pockets in the planting media.
 2. On level ground and on relatively gentle slopes, leave a shallow basin, the diameter of the plant pit, around each plant.
 3. On steep slopes, pull sufficient soil to the lower side of the plant to form a shallow basin to catch and hold water.
 4. Backfilling Planting Pits:
 - a. Backfill tree planting pits with clean native topsoil taken from the Site as the box sides are progressively removed to minimize damage to the root ball and to prevent it from collapsing.
 - b. Backfill palm planting pits the same as tree planting pits, except use backfill consisting of 25 percent palm sand and 75 percent native topsoil.
 - c. Backfill the bottom of the planting pits to prevent undue settling.
 - d. Backfill plants with prepared soil that will be thoroughly settled by watering and tamping to fill all voids.
 5. Palm Tree Backfilling Planting Pits:
 - a. Backfill shall be 100 percent clean washed concrete sand. Palms shall be placed in the pit and watered in as they are backfilled. Watering shall be done with a pipe sticker, six foot length topped with a 90 degree elbow and placed on the end of at least a 3/4 inch hose with adequate water volume to settle the backfill materials. One laborer shall work the sticker up and down, washing the sand down around



- the rootball as the backfilling is accomplished. The backfill sand shall be thoroughly saturated, all around the periphery of the root boll, before going on to the next palm. It is of the utmost importance that this procedure occur as each palm is being planted, following this procedure later in the day or waiting for the next day to perform this function is considered unacceptable and may result in replanting effort and or replacement of the palm tree.
- b. After planting provide five (5) gallons of a water soluble micronutrient fertilizer such as "Wood Ace" Palm Fertilizer by Vigoro, "Soluble Stem" by Peters Fertilizer or "Minor Gro" manufactured by W.R. Grace and Company. Submit selected manufacturer instructions and analysis to the Engineer for approval prior to use.
 - c. After planting, drench the soil with the fungicide "SUBDUE" by Ciba-Giegy or approved equal at the manufacturers recommendations by flooding the planting basin. Reapply as often as label permits throughout the landscape establishment phase.
 - d. Contractor shall be required to apply a foliar drench of each palms fronds and bud starting at 14 calendar days following planting and then once a month at manufacture recommended ratios until the end of the landscape establishment phase. Foliar drench products include but are not limited to:
 - 1) Kocide Copper T.S. fungicide
 - 2) Manzate dithane flowable fungicide
 - 3) Benelate fungicide
 - e. After four weeks, contractor shall apply four (4) pounds of Engineer approved palm tree granular fertilizer per palm tree. Contractor shall reapply at six month intervals. Place fertilizer in a one inch band around the base of each Palm.
 - f. Contractor shall install all other elements shown on the details within the plan set when planting the palm trees.
- G. Watering and Filling:
- 1. Water the trees at planting and as needed until the permanent automatic irrigation system is installed and operating.
 - 2. For watering palms initially, use a 6-foot long pipe sticker topped with a 90 degree elbow at the end of a 3/4 inch hose to water the palm at planting, but not afterwards.
 - a. Water the sand as planting and backfilling occurs.
 - b. Dispense the initial application of disease control for the palms into the backfill watering in accordance with the recommendations of the licensed Pest Control Advisor.
 - 3. Water-compact the topsoil to the extent approved by the Program/Project Manager.
 - a. After settlement, supply additional topsoil as required to make a constant finished grade as detailed.



H. Fertilization:

1. After placing backfill, but prior to final watering and mulching, apply fertilizer to all plants at the following rates:
 - a. Evergreen Trees: 1/8 pound per foot of height.
 - b. Shade Tree: 2 pounds per inch of caliper.
 - c. Deciduous Shrub: 1/4 pound per foot of height.
 - d. Evergreen Shrub: 1/8 pound per foot of height.
 - e. Flowering Tree: 1 pound per inch of caliper.
 - f. Ornamental Grass: 1 pound per 100 square feet.
 - g. Bulbs: 2 pounds per 100 square feet.
 - h. Ground Cover: 20 to 40 pounds per 1,000 square feet.
 - i. Perennials: 1 pound per 100 square feet.

I. Applying Plant Mulch:

1. Remove weeds and deleterious materials from the area before spreading plant mulch.
2. Mulch plant beds and pits as follows:
 - a. Mulch plants after they are planted with tanbark to a uniform depth of 3 inches.
 - 1) Except in during winter planting, place mulch within 2 days after planting.
 - a) In the case of winter planting, place mulch immediately.
 - 2) Mulch tree pits to the outer edge of the earth berm.
 - 3) Mulch the shrub plantings, which are masses, with mulch covering the entire area within the limits of the plant mass.
 - 4) Adjust grades, allowing for the thickness of the mulch by cutting or filling.
 - b. Rake the surface smooth and even over the prepared surface.
 - c. After leveling the mulch, thoroughly soak it with water to the full depth of the mulch.

J. Pruning:

1. Prune new plant material as necessary to remove injured twigs and branches and to compensate for loss of roots during transplanting, but never prune more than half of the original branch structure.
 - a. Only prune damaged or broken main roots of new materials with a clean oblique cut immediately above the point of damage.
 - b. Conform pruning operations to the best horticultural practices with due respect to natural form and growth characteristics of the individual species.
2. Prune the tops of all deciduous stock at the time of planting or immediately thereafter.
 - a. Preserve a single terminal leader when pruning deciduous trees.
 - b. Paint cuts over 3/4-inch in diameter with an approved tree-wound paint.



3. Prune existing trees indicated to remain to remove all dead and interfacing branches.
 - a. Remove lower branches to provide a minimum clearance of 5 feet from finished grade
 - b. Paint cuts over 3/4-inch in diameter with an approved tree-wound paint.
 4. Do not trim any green or partially green fronds during the landscape establishment phase unless directed by the Engineer.
- K. Interface with Other Work:
1. Irrigation System
 - a. Do not begin planting until the irrigation system has been installed and accepted either in total or in increments, except as noted in Subparagraph 3.02.B.5.c.
 - b. Use the newly constructed irrigation system to provide the initial watering and all subsequent watering of the planting.
 - c. Boxed trees and palms may be placed before irrigation system installation.
 - 1) Maintain these boxed plants in prime condition until the irrigation system is automated by providing them with adequate water.

3.05 REPAIR/RESTORATION

- A. Repair or replace damaged structures, plants, and similar items in which damage resulted from planting operations at no increase in Contract Price.
1. Photograph existing conditions impacted by landscape installation.
 2. Limits of Repair/Restoration Work:
 - a. The limits of this work are determined by the limit of disturbance, or as necessary to complete the satisfactory restoration of impacted systems or items, including, but not limited to, the following:
 - 1) Restoration of existing landscaping and irrigation systems.
 - 2) Removal, relocation, or replacement of existing landscape plants, inert groundcovers, or other materials or surfaces disturbed by the Work of this Contract.
 - 3) Restoration and repair of structures as necessary return them to their original condition prior to construction.
 - a) Repair may include, but not be limited to, concrete, masonry, stucco, painting, utilities, and signage.
 3. For non-turf landscaped areas, restore the granite, rock, soil, or other existing landscape surfacing using material to match the existing in type and quality.
 4. Existing Underground Installations:
 - a. Repair any damage to existing underground installations resulting from landscaping operations at no increase in Contract Price.



5. Provide a sample of the replacement materials prior to performing replacement work.
 - a. Existing undamaged materials may be reused for restoration work, subject to the approval of the Program/Project Manager.
6. Neatly join, course, connect, attach, or butt (as applicable) the restoration work to the existing construction, and match the color, texture, and appearance of the existing construction to the satisfaction of the Program/Project Manager.
7. If damage to the structures, grounds, equipment, and/or their contents develops within the stipulated warranty period and is due to the use of material or workmanship which are inferior, defective, or not in accordance with this Contract, make good all unsatisfactory conditions or damage, and make good any work or materials or grounds which are disturbed in fulfilling the requirements of the warranty.
 - a. Make such additional repairs and replacements as required by the Program/Project Manager at no increase in contract Price.

B. Replacement Plants:

1. Provide replacements for any damaged plants in accordance with the requirements of this Section and the warranty provisions.
 - a. If a plant dies or deforms after acceptance but during the warranty period, remove and replace it immediately; or, in the case of plants requiring proper seasonal planting, replace it in the next appropriate season, even if that season falls beyond the warranty period.
 - 1) If a large portion of a plant dies back causing a permanent or long-term deformity, replace it.
 - 2) Replace plants as many times as necessary in a single location during the warranty period.
 - 3) Replace all plants that are dead, unhealthy, or in a badly damaged condition with plants of the same exact type, species, and size originally specified. Note this size replacement does not apply to Saguaro's replacements for Saguaro's that perish and have to be replaced shall include replacement with a six (6) foot spear.
 - 4) Do not make replacements during seasons definitely unfavorable for planting.
 - 5) Remove rejected trees or shrubs immediately from the Site, at no increase in contract Price.
 - 6) Any delay on the part of the Contractor in removing and replacing unsatisfactory materials is cause for the Owner to have such work performed, and to back charge the Contractor for that work.

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C. Existing Plant Materials



1. Replace any existing plants outside the construction limits that are removed, damaged, or destroyed during construction with plants of the same size, and variety at no increase in Contract Price.
2. Replace any plants designated as "preserve in place" that are removed, damaged, or destroyed during construction with trees and shrubs of the same species, size, and variety at no increase in Contract Price.

3.06 SITE QUALITY CONTROL

A. Inspections:

1. Inspections for acceptance of the planting stock prior to the plants being placed in their permanent position will be made at the planting site.
 - a. At the conclusion of the maintenance period, the Program/Project Manager will make an inspection of the landscaping work to determine its condition for acceptance. Final Acceptance
2. Substantial Completion:
 - a. Substantial Completion, as defined in Section 01770, Closeout Procedures, will be granted only when 100 percent of the irrigation system and associated items are installed.
 - b. At Substantial Completion, a Conditional Acceptance of landscape planting and irrigation work may be granted.
 - c. Pre-Maintenance Observation:
 - 1) A pre-maintenance observation of the landscape planting and irrigation work under this Contract will be performed upon Substantial Completion.
 - 2) A punch list of landscape planting and irrigation work items requiring remedial work will be generated.
 - 3) Be sure to have a representative present at the Pre-Maintenance Observation.
 - 4) Upon completion and acceptance of the punch list items, the Plant Establishment Period, will begin.
 - 5) Document and submit the date initiating the Plant Establishment Period it at that time.
3. Plant Establishment Period:
 - a. Whenever the planting and related Work has been substantially completed, upon request from the Contractor the Program/Project Manager will perform an initial inspection.
 - b. After this initial inspection, and subject to approval of the Work, the Program/Project Manager will issue a written field notification setting the effective beginning date for the Plant Establishment Period.
 - c. The Plant Establishment Period will last for a period of at least 90 calendar days, but is subject to extension by the Program/Project Manager if the landscape areas are improperly maintained, appreciable plant replacement is required, or other corrective work becomes necessary.



- d. At the end of the Plant Establishment Period or at Final Acceptance, the Program/Project Manager will make a final acceptance inspection of the planted areas.
- e. If the termination of the Plant Establishment Period extends beyond the Final Acceptance date for the Contract, the additional period of time for plant establishment will be considered as a special warranty period within the standard one-year warranty period, and the Program/Project Manager may authorize final payment in accordance with the Agreement.
- 4. Keep a copy of the Contract Drawings and Specifications available at the Site until Final Acceptance.
- B. Non-Conforming Work
 - 1. All plants which settle deeper than the surrounding grade will be rejected and must be raised to the correct level.

3.07 CLEANING

- A. Leave the sites of planting in a clean, safe, neat condition; and not in an unsightly condition.
- B. Remove debris and/or toxic material from planting areas prior to beginning planting.
- C. Waste Management:
 - 1. As the landscape work is completed during the Contract, and at intervals as directed by the Program/Project Manager, clear the Site of all rubbish or debris, and of extraneous materials, including quantities of subsoil, rock, and other spoils remaining from excavation after planting.
 - a. Remove excess and waste material from the Site daily, and keep adjacent areas cleared.
 - b. Immediately remove rejected and unacceptable material from the Site and dispose of it properly.
 - c. At the end of the 1-year warranty period, remove all guying materials.
 - 2. Dispose of dead plant materials off-site at no increase in Contract Price.
 - a. During the preparation of shrub beds, and after the 7-day waiting period beyond the final post-emergent herbicide application, dispose of woody plant stumps and any existing vegetation not killed by the herbicide application off-site as specified in Subparagraphs 3.03.B.1.c.5 and 3.03.B.1.c.6.

3.08 CLOSEOUT ACTIVITIES

- A. Maintenance Instructions:



1. Prior to the expiration of the required maintenance period, submit typewritten recommended procedures to be established by the Owner to maintain landscape work for 1 full year.

3.09 PROTECTION

A. Staking and Bracing Plants:

1. After plant setting work, install guy stakes and guy supports on those plants indicated as being staked to prevent uprooting by wind or otherwise.
2. Staking Trees:
 - a. Within 3 days after planting, stake trees as follows:
 - 1) Stake trees up to 2 inches caliper and evergreen plants 6 feet tall and taller with 2 guy stakes placed on opposite sides of the tree, with a top tie placed for maximum support and a tie placed midway between the top and ground.
 - a) Provide extra ties if in the opinion of the Program/Project Manager they are needed.
 - 2) Stake trees 2 inches caliper with 3 stakes.
 - b. Stake trees at the perimeter line of the root ball as detailed on the Contract Drawings.
 - c. Drive stakes vertically, and not twisted or pulled, and to a sufficient depth into firm ground to hold the tree rigid, but do not injure the root ball.
 - d. Replace or pound flush with the top of the soil stakes with a broken or jagged top.
 - e. Avoid rigid restraint of the tree, and allow for some trunk movement as shown in the planting details.
3. Guy Wire:
 - a. Do not allow guy wire to come in contact with the plants.
 - b. Cover guy wire with rubber hose as shown in the Contract Drawings where such contact points would otherwise occur.
4. Do not locate stakes and guy supports where pedestrian safety would be endangered.
5. Brace palms, yuccas, and saguaros as shown in the details.

3.10 MAINTENANCE

A. Plant Maintenance Period:

1. Begin maintenance operations immediately after planting is performed and continue them throughout construction.
2. Maintain landscaped areas on a continuous basis as they are completed during the course of the Work and until Final Acceptance or the termination of the Plant Establishment Period, whichever occurs later.
 - a. This continuous maintenance period is the Plant Maintenance Period.



B. Maintenance Requirements:

1. Maintenance activities include, but are not limited to, performing the following activities:
 - a. Insuring that all plants are in a sound, healthy, and vigorous condition free from insects, diseases, bark abrasions, or other objectionable disfigurements.
 - b. Weeding and cultivating the planted areas at intervals acceptable to the Program/Project Manager.
 - c. Applying mulch as needed and maintaining mulched landscaped areas throughout the warranty period as specified, including rescuing and replacing mulch that has sloughed off and weeding mulched areas.
 - d. Pruning and re-staking plants as directed by the Program/Project Manager.
 - 1) Maintain and adjust stake wires if necessary and rewrap tree trunks when necessary.
 - 2) Perform pruning, other than the initial pruning, as necessary to remove dead leaders and branches.
 - e. Replacing any plant that is unacceptable at any time up to and including Final Acceptance of the Contract or completion of the Plant Establishment Period, whichever comes later.
 - 1) Replace any dead or dying plant material as directed by the Program/Project Manager.
 - f. Removing all errant trash and debris from the landscape areas on a continuous basis or as necessary.
 - g. Performing other particular operations as specified.
2. Palm Disease Control
 - a. Six weeks after installation of palms, or during periods of high humidity and warm temperatures, request an inspection of each palm by a Licensed Pest Control Advisor, and obtain information regarding application of compounds for palm bud rot.
 - b. Inspect palms monthly for palm bud rot.
3. Palm Fertilization:
 - a. Do not apply fertilizer for 6 to 8 weeks after planting a palm.
 - b. After 8 weeks, apply 3 pounds of 3:1:3 plus micronutrients fertilizer and 1 pound of magnesium sulfate ($MgSO_4$) on *Washingtonia filifera* palms.
 - c. Thoroughly water-in fertilizers.
 - d. Contractor shall provide a maintenance report to the Engineer monthly on the status of the health of the palms. Contractor shall take immediate action if the palm trees show a decline in health and or issues that are detrimental to the palms survival and establishment.
 - e. Contractor shall be required to check for water penetration as well as drainage throughout the root zone once a week and monthly thereafter until the end of the landscape establishment. These findings



shall be entered into a log with the dates and initials of person verifying the drainage. Monitoring shall be done the day prior to applying supplemental water. After the initial watering-in, water the palms with a good soaking, 40-50 gallons per palm every day. Watering amounts and schedule are estimates and are subject to change by Engineer after reviewing the log and observations in the field.

- f. Unless otherwise specified by the Engineer, the contractor shall be responsible for the cost of replacement and planting of any palm tree, in kind at like height that is not in a vigorous growing condition as determined by the Engineer or the palm does not survive. Palm height is measured from the existing grade line around the palm to base of the growing palm bud.
 - g. Palms that do not survive the removal, storage and planting become the property of the contractor for disposal. Contractor shall replace all dead and or palm trees rejected by the Engineer for health reasons within five (5) working days from notice by Engineer.
 4. Continue maintenance activities for a period of at least 1 year from the time of acceptance.
 5. Provide adequate personnel to perform the required maintenance.
- C. Watering:
1. Thoroughly water plants at least bi-weekly and in a satisfactory manner during the construction period until acceptance.
 - a. Water plant root systems at regular intervals and keep the surrounding soil in condition to promote root growth.
 2. Provide all necessary water, tank trucks, hoses, and appurtenances.
- D. Palm Care after Planting:
1. In the summer, untie the top tie on fronds 30 days after planting; and cut the bottom tie 45 days later.
 2. In cooler months, untie the top and bottom ties after 90 days, or when new shoots have pushed up beyond the top of the existing fronds.
 3. Do not prune palms for a minimum 30 days after removal of the bottom tie.
 4. Remove braces when the bottom tie is cut.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition
1	11/15/2017	N/A	All	Edited by J2
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Phoenix Sky Harbor International Airport
PHX Sky Train
Contract No. AV10000011-1

Planting
July 9, 2018

02900-40
Revision 2



SECTION 02919

TOPSOIL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the preparation and fine grading of topsoil subgrade.
 - 2. Requirements for furnishing, spreading, and testing topsoil and humus.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 02925 - Seeding and Soil Supplements.

1.02 REFERENCE STANDARDS:

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T 89, Standard Method of Test for Determining the Liquid Limit of Soils.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM E 329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- C. Association of Analytical Communities International (AOAC):
 - 1. AOAC Official Methods of Analysis of AOAC International.

1.03 SUBMITTALS

- A. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Topsoil and humus analysis and recommendations for soil supplements per Subparagraph 3.01.B.1 and 3.03.E.1.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Quality Assurance Testing and Inspection Agency Qualifications:
 - a. Employ an independent quality assurance testing and inspection agency qualified to perform the inspections and testing required by this Section.



- b. The independent quality assurance testing and inspection agency must conform to the quality standards of the nationally recognized associations and agencies that promulgate the test standards, particularly ASTM E 329.
- c. Materials are subject to inspection and testing in the nursery and field by the independent quality assurance testing and inspection agency.
 - 1) Direct the independent quality assurance testing and inspection agency to submit certified written reports that document the results of all tests and inspections performed directly to the Engineer immediately after the work is performed.
 - a) In the reports, state whether the tested and inspected items comply with specified requirements or deviate from them.
 - 2) Inspections and tests performed by the quality assurance testing and inspection agency do not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

1.05 SITE CONDITIONS

A. Ambient Conditions:

- 1. Do not perform finish grading during unsuitable weather.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil:

- 1. On-site, previously stripped topsoil that has been stockpiled for reuse may be used for planting and seeding operations.
 - a. Use topsoil of uniform quality, free from hard clods, roots, sods, stiff clay, hard pan, stones larger than 1 inch, lime cement, ashes, slag, concrete, tar residue, tarred paper, boards, chips, sticks or any undesirable material.
- 2. If additional imported topsoil is required for planting and seeding backfill, provide topsoil that meets the following requirements from an approved off-site source:
 - a. Provide new topsoil consisting entirely of earth and organic materials that are fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.
 - 1) Obtain topsoil from local sources, or from areas having suitable soil characteristics, where the soil has the proven ability to grow crops.
 - a) Before delivering the topsoil to the Site, submit a written statement certifying the locations of the properties from where



the topsoil is to be obtained, the names and addresses of the owners, the depth to be stripped, the crops grown, and the fertilizers and pesticides applied during the past 2 years.

- 2) Obtain topsoil only from naturally, well-drained sites where topsoil occurs to a depth of not less than 4 inches.
 - a) Do not obtain topsoil from bogs or marshes.
 3. Limit the maximum particle size to that capable of being readily placed and compacted in loose 6-inch layers.
 4. If necessary, take steps to make it conform to the acceptable pH acidity range and percentage of organic matter specified:
- B. Water:
1. Provide water suitable for irrigation and free from ingredients harmful to plant life.
- C. Humus:
1. Provide dark brown to black domestic natural humus consisting of reed or sedge peat, granulated and free of lumps, that can be readily incorporated into topsoil, and meets the following requirements:
 - a. Size: Provide humus capable of passing through a 1/2-inch screen.
 - b. Composition:
 - 1) Provide humus free from sticks, stones, weedy roots, or other foreign matter; and having ample water-holding capacity and ability to retain plant food.
 - 2) Provide humus low in wood material, iron, and sulfur ash content.
 - c. Percent Moisture: Between 35 and 50 percent when delivered from stockpiles.
 2. Acceptable Products:
 - a. Humall Peat as supplied by Pennsylvania Peat Moss, Inc., Hazleton, Pennsylvania.
 - b. Or approved equal.

2.02 EQUIPMENT

- A. Compaction Roller:
1. Furnish a compaction roller weighing approximately 500 pounds.
- B. Watering Equipment:
1. Furnish hose and other watering equipment required for the work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Pre-Installation Testing:
1. Topsoil:



- a. Test on-site, previously stripped topsoil that has been stockpiled for reuse and imported topsoil to certify that it meets the following requirements:
- 1) Acidity Test:
 - a) Test Procedure:
 - (1) Test the acidity of the soil.
 - b) Acceptance Criteria:
 - (1) Acidity Range: pH 5.0 to pH 7.0, inclusive, is acceptable.
 - 2) Percent Organic Matter Test:
 - a) Test Procedure:
 - (1) Determine the percent organic matter by loss on ignition of moisture-free samples dried in accordance with the current method of the AOAC Official Methods of Analysis of AOAC International.
 - b) Acceptance Criteria:
 - (1) Topsoil must contain at least 5 percent organic matter.
 - 3) Dry Weight Density Test:
 - a) Test Procedure:
 - (1) Determine the Dry Weight Density.
 - b) Acceptance Criteria:
 - (1) 95 pounds per cubic foot, minimum, is acceptable.
 - 4) Liquid Limit (Maximum) Test:
 - a) Test Procedure:
 - (1) Determine the maximum liquid limit in accordance with the procedures specified in AASHTO T 89.
 - b) Acceptance Criteria:
 - (1) 65 or less is acceptable.
 - 5) Gradation Analysis:
 - a) Test Procedure:
 - (1) Use U.S. Standard sieves to gradate the topsoil.
 - b) Acceptance Criteria:
 - (1) Provide topsoil with a gradation per Table 02919-1.

Table 02919-1 Topsoil Gradation Analysis	
Sieve Size	Minimum Percent Passing
2 inch	100
Number 4	75
Number 10	60
Number 200	35

2. Humus:



- a. Test the humus to verify that it meets the following requirements:
 - 1) Acidity Test:
 - a) Test Procedure:
 - (1) Test the acidity of the soil.
 - b) Acceptance Criteria:
 - (1) Acidity Range: pH 5.0 to pH 7.0 (intensity to acidity), inclusive, is acceptable.
 - 2) Moisture Test:
 - a) Test Procedure:
 - (1) Determine the weight loss upon oven drying of the humus.
 - b) Acceptance Criteria:
 - (1) 60-75 percent weight loss upon oven drying is acceptable.
 - 3) Water Absorption Test:
 - a) Test Procedure:
 - (1) Determine the water absorbing ability of the humus.
 - b) Acceptance Criteria:
 - (1) 150 to 350 percent, inclusive, is acceptable.
 - 4) Percent Organic Matter Test:
 - a) Test Procedure:
 - (1) Determine the percent organic matter by loss on ignition of moisture-free samples dried in accordance with the current method of the AOAC Official Methods of Analysis of AOAC International.
 - (2) Dry the sample at 110 degrees Celsius prior to combustion.
 - b) Acceptance Criteria:
 - (1) Humus must contain at least 80 percent organic matter on a dry basis.
 - (2) Humus must contain at most 10 percent wood material, iron, and sulfur ash on a dry basis.

B. Evaluation and Assessment:

- 1. Submit topsoil and humus test reports of the tests to the Engineer for approval.

3.02 PREPARATION

A. Demolition / Removal:

- 1. After construction work is finished and rough grading has settled and been approved but prior to finish grading, remove all sticks, stones, and foreign material one inch or greater in size from the subgrade to receive topsoil.

B. Surface Preparation:

- 1. Harrow or otherwise loosen the subgrade to a depth of 3 to 4 inches.



3.03 APPLICATION

- A. Provide topsoil for all areas within the limits of the Contract that meet both of the following criteria:
 - 1. Areas disturbed by changes in grade, site clearing, or Contractor operations.
 - 2. Areas not to be paved, not containing plantings or structures, and that will not be disturbed by utility construction.
- B. Spreading Topsoil:
 - 1. Spread topsoil over areas to be seeded, planted, or scheduled to receive additional topsoil; and conform it smoothly to the lines, grades, and elevations shown on the Contract Drawings.
 - a. Spread topsoil to a depth of 6 inches, after natural settlement.
- C. Grading Topsoil:
 - 1. After spreading the topsoil, rake up large stiff clods, hard lumps, roots, litter, and other foreign matter and stones larger than 3/4 inch in their greatest dimension.
 - a. Remove this raked material from the premises, or dispose of it where directed in a satisfactory manner.
 - 2. Fine grade and rake the topsoiled areas to a smooth, uniform surface.
 - a. Apply humus to the surface of the spread topsoil, and work it into the mix during raking operations.
 - b. Apply a quantity of humus as necessary to meet the 5 percent organic matter content specified.
- D. Compacting Topsoil:
 - 1. Compact the topsoil with an approved roller.
 - 2. Re-grade and re-roll the topsoil until satisfactory grades as shown on the Contract Drawings are obtained having the required depths of topsoil
- E. Prepare the topsoiled areas for seeding and lawn establishment.
 - 1. Soil Supplements:
 - a. After performing topsoil testing, determine the soil analysis and submit soil supplement recommendations to the Engineer for approval.
 - 1) Prior to adding any soil supplements to the topsoil, take a sufficient quantity of topsoil samples to allow a representative analysis of on-site topsoil and imported topsoil from outside sources, if any.
 - 2) Have the Quality Assurance Testing and Inspection Agency perform the testing specified in Paragraph 3.01.A.
 - 3) Provide recommendations for both the grade and application rates of fertilizer and such other soil supplements as required.
 - b. Apply lime and fertilizer mixed as specified in Section 02925, Seeding and Soil Supplements.



3.04 ADJUSTING

- A. If necessary, make the topsoil conform to the pH acidity range and percentage of organic matter listed in Subparagraphs 3.01.A.1.a.
1. All material unsuitable for use as topsoil becomes the property of the Contractor), and he must expeditiously remove it from the Site.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition





SECTION 03100

CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for designing and providing concrete formwork, falsework, bracing, and shoring for constructing the concrete structures depicted on the Contract Drawings and specified in the Specifications.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01400 - Quality Requirements.
3. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. ACA: An acronym for Ammoniacal Copper Arsenate, a leach-resistant waterborne wood preservative.
2. CCA: An acronym for Chromated Copper Arsenate, a leach-resistant waterborne wood preservative.
3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Reference Standards:

1. American Concrete Institute (ACI):
 - a. ACI 347-14 - Guide to Formwork for Concrete.
2. APA-The Engineered Wood Association (APA):
 - a. APA Panel Handbook & Grade Glossary.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. Southern Pine Inspection Bureau (SPIB):
 - a. SPIB Standard Grading Rules for Southern Pine Lumber.
5. State of Arizona:
 - a. Arizona Department of Transportation (ADOT):
 - 1) ADOT 2008 Standard Specifications for Road and Bridge Construction.
6. U. S. Government:
 - a. U.S. Department of Commerce:
 - 1) Product Standards:



Forms for Curb & Gutter and Sidewalk

It is acceptable to use standard lumber sizes as formwork for curb, gutter, and sidewalks.



- a) PS-1-95 - Construction and Industrial Plywood.
 - b) PS-20-94 - American Softwood Lumber.
- 7. Western Wood Products Association (WWPA):
 - a. WWPA G5 - Western Lumber Grading Rules '05.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure they receive notification sufficiently early to allow them ample time to schedule and perform the required testing and inspections performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring this testing into the Work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Form ties per Subparagraph 2.03.A.
 - 2) Form coating materials per Subparagraph 2.03.B.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- B. Qualifications:
 - 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
 - 2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the



qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Design the formwork and falsework in accordance with ACI 347 and with the following:
 - 1. Capacities:
 - a. In the design, include assumed values of live load, dead load, weight of moving equipment operated on the formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of the structure during construction.
 - 2. Design the formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.
 - 3. Design the formwork to conform to the concrete sections indicated on the Contract Drawings, and provide concrete within the following ACI 347 tolerances:
 - a. Concrete Surfaces Exposed to Public View: Class A tolerance.
 - b. Concrete Surfaces Not Exposed to Public View: Class C tolerance.
 - c. Where stricter tolerances are indicated on the Contract Drawings, they supersede the ACI tolerances specified herein.
 - 4. Include the factors pertinent to the safety of personnel during construction in the design.
 - 5. Types of Formwork and Falsework Permitted:
 - a. Exposed Finish Concrete:
 - 1) Design and furnish formwork of metal, fiberglass, or other materials that provide a smooth, uniform concrete surface texture.
 - 2) Do not design and furnish formwork of materials having a raised grain, torn surfaces, worn edges, or other defects that will impair the concrete surface texture.
 - b. Unexposed Finish Concrete:
 - 1) Design and furnish formwork of plywood, lumber, metal, or another acceptable material.
 - c. Earth forms are not permitted.

2.02 MATERIALS:

- A. Form Sheathing and Panels:
 - 1. For form sheathing and panels, provide Exterior Type B-B Plywood Class I and II that conforms to U.S. Product Standard PS-1-95.
 - a. Thickness: 5/8 inch, minimum.
 - b. On surfaces not exposed to view, only use Class II plywood.



- B. Framing, Sheathing, Struts, Braces, and Shoring for Forms:
 - 1. Provide framing, sheathing, struts, braces, and shoring for the forms made from lumber conforming to WWPAA Grading Rules or SPIB Grading Rules.
- C. Metal Forms:
 - 1. Furnish steel forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Contract Drawings.
 - 2. Do not provide stay-in-place metal forms except as follows:
 - a. With the approval of the Program/Project Manager only, stay-in-place metal forms may be used for building structures.
 - b. Stay-in-place metal forms may be used for cast-in-place concrete decks on elevated guideway.
- D. Rough Structural and Dimension Lumber:
 - 1. Provide lumber of allowable species, surfaced on four sides as applicable, and grade stamped with the appropriate WWPAA or SPIB stamp indicating product compliance with PS-20-94.

2.03 ACCESSORIES

- A. Form Ties:
 - 1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties conforming to ACI 347.
 - a. Do not fabricate wire ties, flat bands, or form ties on the Site.
 - 2. Removable Ties:
 - a. For ties that are designed to be completely removed, taper the ties over their full length that passes through the concrete.
 - 1) In building foundation walls, install tapered ties so the large end of the taper is on the ground side of the concrete wall.
 - b. Do not use removable type ties that leave holes larger than one inch.
 - 3. Snap-off Metal Ties:
 - a. Provide snap-off metal ties with ends that break at least 1-1/2 inches from the face of the wall.
 - 4. Do not use wood spacers.
 - 5. To construct structures designed to exclude groundwater, use ties designed to prevent seepage or flow of water along the embedded tie.
 - 6. Submit Product Data and current specifications for the form tie materials.
- B. Form Coatings:
 - 1. Provide commercial formulation VOC compliant form-coating compounds that do not bond with, stain, or affect concrete surfaces.
 - a. Provide form-coating compounds that do not impair subsequent treatment of concrete surfaces requiring bond or adhesion, or impede the wetting of surfaces to be cured with water or curing compounds.
 - 2. Submit current Product Data for the form coating materials.



PART 3 EXECUTION

3.01 PROTECTION OF IN-PLACE CONDITIONS:

- A. Protect in-place materials and the work of other trades during concrete work.

3.02 ERECTION

- A. Construct the forms in accordance with ACI 347 and to the required dimensions.
 - 1. Fabricate the forms for easy removal without hammering or prying against concrete surfaces.
 - 2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and such other features as required.
- B. Erect the forms plumb, straight, mortar tight, and paste tight where appearance is important.
 - 1. Form intersecting planes so that true, clean-cut corners are created.
 - 2. Do not expose the concrete surfaces to the edge grain of plywood used to fabricate forms.
- C. Openings:
 - 1. Provide temporary openings where the interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, or for placement of concrete.
 - a. Locate temporary openings on forms in locations as inconspicuous as possible consistent with the requirements of the work.
 - b. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through the forms.
 - 2. Securely brace and set temporary openings tightly to forms to prevent the loss of concrete mortar.
- D. Securely brace and shore the forms to prevent displacement, bowing, pillowing, and to safely support the imposed concrete load.
- E. Prior to the concrete pour, wet wood forms sufficiently to prevent the joints from opening
- F. Form Coatings:
 - 1. Apply form coatings in accordance with the coating manufacturer's specifications.
 - 2. Do not allow form coatings to come in contact with construction joints and reinforcing steel.
 - 3. Do not allow excess form coating material to accumulate in the forms.
- G. Interface with Other Work:



1. Build items such as inserts, anchors, miscellaneous metal items, and other embedded items indicated on the Contract Drawings into the forms; or otherwise secure these items in the forms.
 - a. Accurately place and securely support items to be built into forms.

H. Tolerances:

1. Set and maintain concrete forms within the allowable tolerance limits specified in Subparagraph 2.01.A.3.
2. For forms and falsework for elevated guideway, comply with the additional tolerance requirements specified in Subsection 601-3.02 in the ADOT Standard Specifications for Road and Bridge Construction.

3.03 REMOVAL

- A. The Program/Project Manager's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the Work.
- B. If the atmospheric temperature at the Site has been continuously above 50 degrees Fahrenheit from the time of the pour, remove the forms at the earliest practical time within the limits set forth in this Article 3.03, and maintain wet curing without delay.
 1. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal, and provided these members are not subjected to loads for a period of 14 days.
 2. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3000 psi.
 3. If a water-reducing retarder is used in the concrete mix, the normal time period for removing forms may need to be increased.
- C. ~~If the atmospheric temperature at the site drops below 50 degrees Fahrenheit, leave all forms in place for at least 5 days regardless of the temperature within protective coverings or enclosures.~~ Follow provisions in ACI 306R
- D. Remove forms in accordance with ACI 347 without damaging the concrete and in a manner that ensures complete safety and serviceability of the structure.
 1. Do not cut form ties back from the face of the concrete.
- E. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support the weight of the members and the anticipated construction loads without distortion or excessive deflection.

Cold Weather Concreting & Formwork

RFI
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3.04 RE-INSTALLATION

- A. Forms may be re-used, only if they meet the same requirements as new forms with respect to their effect on poured concrete appearance and structural stability.
- B. Reusing forms may not cause delays or changes in the concrete pour schedule when compared to the concrete pour schedule that is made possible by using all new forms in the case of wood forms, or by having available the total number of forms required in the case of metal forms.

3.05 SITE QUALITY CONTROL

- A. Inspections:
 - 1. Notify the Program/Project Manager at least 10 days prior to scheduled concrete placement operations to allow sufficient time for the code-required Approved Agency responsible for performing special inspections to schedule an inspection of the concrete formwork.
 - 2. Prior to placement of concrete, inspect the forms for shape, location, and dimension of the concrete member being formed.
 - a. Provide lumber free of material defects that would unacceptably deform the finished concrete product or cause visible imperfections on surfaces exposed to public view.
 - 3. Prior to placement of concrete, verify the items to be embedded are properly placed and anchored.
 - 4. Notify the Program/Project Manager upon removal of each concrete form so a review of the newly stripped surfaces may be made before patching takes place.
 - 5. Examine concrete surfaces following removal of forms to verify the surface does not contain residual form coating that will interfere with other materials or coatings to be applied.
- B. Non-Conforming Work
 - 1. If formwork is found to be out of alignment, or requires residual or other detrimental material to be removed from the forms or pour area, realign the forms and/or remove the detrimental material from the formwork before pouring concrete into the form.
 - 2. If detrimental form coating is found, use approved methods to remove it prior to applying other materials or coatings.

3.06 WASTE MANAGEMENT AND DISPOSAL:

- A. Do not leave any wood, shavings, sawdust, and similar items on the ground or buried in backfill.
 - 1. Do not burn scrap on the Work Site.
 - a. Do not burn scraps that have been pressure treated.



2. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.

- B. Prevent sawdust and wood shavings from entering the storm drainage system.

3.07 PROTECTION

- A. Protect formwork materials before, during, and after erection to ensure acceptable finished concrete work.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	03/02/2018	N/A	1.02.B	Correct Reference Standards



SECTION 03150

VERTICAL RESTRAINERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing vertical restrainer units for elevated guideway structures as detailed on the Contract Drawings at the locations indicated thereon.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 05120 - Structural Steel.

1.02 REFERENCE STANDARDS:

- A. American National Standards Institute (ANSI):
 - 1. ANSI A135.4 – Basic Hardboard.
- B. ASTM International (ASTM):
 - 1. ASTM A603-98(2014) - Standard Specification for Zinc-Coated Steel Structural Wire Rope.
 - 2. ASTM C203-05a(2017) - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
- C. International Code Council (ICC):
 - 1. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. 10 days before the vertical restrainer units are to be installed, give notice to those performing other construction work related to the vertical restrainer units' installation, such as to those performing work that must be supported by or that will provide support of the vertical restrainer units, to allow such items to be introduced or furnished before the vertical restrainer units are installed.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to ensure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.



B. Sequencing:

1. Sequence the installation of the vertical restrainer units and integrate the installation of the vertical restrainer units into the construction of the abutments and pier caps.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Vertical restrainer units.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Vertical restrainer units and other concrete accessories.
 - b. Site Quality Control Submittals:
 - 1) Vertical restrainer unit test loop assemblies.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section related to vertical restrainer units.

B. Qualifications:

1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the



qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Vertical Restrainer Units:
 - a. Ship the cable assemblies for the vertical restrainer units as a complete unit.
 - 2. Ensure that materials are delivered to the site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - a. Deliver vertical restrainer units to be embedded in or attached to concrete in ample time so that the Work is not delayed.
- B. Storage and Handling Requirements:
 - 1. Handle vertical restrainer units so no parts are bent, broken, or otherwise damaged; and avoid damage to other material and work.
 - a. Exercise care to avoid over stressing the units.
 - b. Replace pieces that are damaged, unless the Program/Project Manager authorizes repairs.
 - 2. Store the vertical restrainer units on platforms, skids, or other supports to prevent contact with dirt, debris, and moisture.
 - a. Protect vertical restrainer units from exposure to conditions that produce rust.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Delegated Design Submittals:
 - 1. Submit the manufacturer's descriptive Product Data, including current specifications, for the vertical restrainer units specified in this Section.
 - 2. Submit the manufacturer's installation instructions for the vertical restrainer units specified in this Section.

2.02 MATERIALS

- A. Vertical Restrainer Units:
 - 1. Provide vertical restrainer units as shown on the Contract Drawings and as follows:
 - a. Cable Assemblies:
 - 1) Provide 3/4-inch diameter preformed cables having a 6 by 19 strand core or an independent wire rope core (IWRC), and having a Class A galvanized coating complying with the requirements specified in ASTM A 603, right regular lay, and manufactured from improved plow steel having a minimum breaking strength of 21 tons (42 kips).



- 2) To prevent separation, securely wrap the free ends of the cable restrainer units at each end.
- 3) Take responsibility for determining the required length of the cable assemblies.
- b. Structural Steel:
 - 1) Provide structural steel components complying with the requirements specified in Section 05120, Structural Steel.
- B. Hardboard:
 1. Provide Class 1 tempered hardboard conforming to the requirements specified in ANSI A135.4.
 2. Surface: Provide plain hardboard having one smooth side (S1S).
 3. Thickness: 1/8 inch minimum, unless otherwise specified or shown on the Contract Drawings.
- C. Preformed Joint Filler:
 1. Provide commercially available expanded polystyrene board having a minimum flexural strength of 35 pounds per square inch determined in accordance with the requirements specified in ASTM C 203.
 2. Compressive Yield Strength: Between 16 and 40 pounds per square inch at 5 percent compression.

2.03 SOURCE QUALITY CONTROL

- A. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when concrete for this Contract is being mixed, placed, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Inspect the locations intended to receive vertical restrainer units for deficiencies which would prevent proper execution of the concrete work.
- B. Evaluation and Assessment:
 1. Do not proceed with vertical restrainer unit installation until deficiencies discovered by the inspection are corrected to the satisfaction of the Program/Project Manager.



3.02 INSTALLATION

- A. Vertical Restrainer Unit:
 - 1. Provide vertical restrainer units at the locations indicated on the Contract Drawings and in accordance with the details shown.
 - a. Pre-position the portions of the vertical restrainer units to be embedded in the pier caps in advance of new concrete pours.
 - b. Provide a means of holding the cable assemblies in their planned positions.
 - c. Seal the openings in the structural tube to prevent intrusion of concrete.
- B. Preformed Joint Filler Installation:
 - 1. Provide expanded polystyrene preformed joint filler on the concrete substrate where shown on the Contract Drawings.
- C. Hardboard Installation:
 - 1. Face the surfaces of the expanded polystyrene with hardboard where shown on the Contract Drawings.
- D. Special Techniques:
 - 1. Perform welding operations in accordance with the requirements specified in Section 05120, Structural Steel.
- E. Interface with Other Work:
 - 1. During superstructure/deck construction, integrate the upper portion of the installed vertical restrainer units extending up from the abutments and pier caps into the concrete end diaphragm pours of the guideway superstructures.

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when vertical restrainer units are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection



later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

2. Vertical Restrainer Unit Cable Assembly Test:

a. Test Procedure:

- 1) Submit a minimum of one vertical restrainer unit test loop assembly for every 40 cable assemblies to the Program/Project Manager for testing.
 - a) Fabricate the test loop assembly from the same lot of material, wire rope, and fittings or clips as the cable assemblies.
 - b) Provide test loop assemblies not less than 27 inches or more than 33 inches long when pulled taut.

b. Acceptance Criteria:

- 1) Cable assemblies complying with the requirements specified will be acceptable.

B. Non-Conforming Work

1. Promptly remove and replace Work that does not comply with specified requirements.
 - a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.
2. Record the work required and the work performed to correct deficiencies in the Work of this Section.

3.04 PROTECTION

- A. Protect vertical restrainer units installed in abutments and pier caps until the upper portion extending up from the pier caps is integrated into the concrete end diaphragm pours during superstructure/deck construction.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	03/02/2018	N/A	All	Change Name From "Concrete Accessories" to "Vertical Restrainers"
			1.02.B	Corrected Reference Standards
			1.03.A	Delete "and deck joint assemblies"



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
			All	Miscellaneous minor adjustments throughout.





SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing concrete reinforcement for concrete structures.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Concrete Institute (ACI):
 - 1. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 2. ACI 318-14 - Building Code Requirements for Structural Concrete.
- B. American Welding Society (AWS):
 - 1. AWS D1.4/D1.4M-2011 Structural Welding Code – Reinforcing Steel.
- C. ASTM International (ASTM):
 - 1. ASTM A1064/A1064M-17 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 2. ASTM A615/A615M-16 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. ASTM A663/A663M-17 - Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - 4. ASTM A706/A706M-16 - Standard Specification for Deformed and Plain Low-Alloy Steel Plain Bars for Concrete Reinforcement.
 - 5. ASTM A970/A970M-17 - Standard Specification for Headed Steel Bars for Concrete Reinforcement.
- D. Concrete Reinforcing Steel Institute (CRSI):
 - 1. CRSI Manual of Standard Practice.
- E. International Code Council (ICC):
 - 1. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 2. ICC-ES Legacy Report ER-3967 – Reinforcing Steel Couplers and Splicers.



3. ICC-ES Legacy Report ER-4028 – Dayton/Richmond Dowel Bar Splice Systems.

F. State of Arizona:

1. Arizona Department of Transportation (ADOT):
 - a. ADOT 2008 Standard Specifications for Road and Bridge Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Reinforcement bars.
 - 2) Weldable reinforcement bars.
 - 3) Welded wire reinforcement (WWR).
 - 4) Wire.
 - 5) Dowel bar splicer system.
 - 6) Bar-lock coupler.
 - 7) Headed deformed bars.
 - 8) Slab joint dowel bars.
 - 9) Deformed bar anchors.
 - 10) Metal Accessories.
 - b. Shop Drawings:
 - 1) Concrete reinforcement drawings.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Installation and storage instructions for the dowel bar splicer system.
 - 2) Installation and storage instructions for the bar lock coupler.



- 3) Installation and storage instructions for the headed deformed bars.
- 4) Installation and storage instructions for the deformed bar anchors.
- b. Source Quality Control Submittals:
 - 1) Certified copies of mill test reports per Subparagraph 2.04.A.2.a (in lieu of the testing required by Subparagraph 2.04.A.2.b).
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating material cost for each product and the fraction by weight that is considered recycled.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- B. Qualifications:
 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
 2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ship reinforcement and accessories to the Site with items of the same size and shape fastened in bundles with securely wired-on identification tags giving the size and mark.
- B. Storage and Handling Requirements:



1. Store concrete reinforcing materials in a manner that prevents excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
 - a. Store the reinforcement and accessories above ground on platforms, skids, or other supports.
 - b. Cover reinforcement and accessories.
 - c. Store the dowel bar splicer systems and the bar lock couplers in accordance with the manufacturer's storage instructions.
2. Protect reinforcement from deforming, bending, kinking, and other injury.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Delegated Design Submittals:
 1. Shop Drawings:
 - a. In accordance with ACI 315, prepare and submit concrete reinforcement Shop Drawings that show all fabrication dimensions and the locations for placing reinforcement and bar supports.
 - 1) Indicate bending diagrams, splicing and lap of rods, shapes, dimensions, and details of bar reinforcing and accessories.
 2. Product Data:
 - a. Submit the manufacturer's descriptive Product Data, including current specifications, for each product proposed for the Work of this Section.
 3. Manufacturer's Instructions:
 - a. Submit manufacturer's installation and storage instructions for the dowel bar splicer system, the bar lock couplers, headed deformed bars, and deformed bar anchors.
- B. Sustainability Requirements:
 1. Sustainability Requirements:
 - a. Recycled Content
 - b. Provide Concrete Reinforcement whose combined post-consumer recycled content and one-half pre-consumer recycled content at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

2.02 MATERIALS

- A. Reinforcing Steel:
 1. Reinforcement Bars:
 - a. Provide deformed steel reinforcement bars in accordance with the requirements for Grade 60 as specified in ASTM A615/A615M.
 2. Weldable Reinforcement Bars:
 - a. Where welding of reinforcement is indicated in the Contract Documents, provide deformed low-alloy steel reinforcement complying



- with the requirements for Grade 60 as specified in ASTM A706/A 706M.
3. Welded Wire Reinforcement (WWR):
 - a. Provide welded wire reinforcement in accordance with the requirements of ASTM A1064/A1064M as may be noted in the Contract Documents.
 4. Wire:
 - a. Provide wire in accordance with the requirements of ASTM A1064/A1064M.
- B. Dowel Bar Splicer System:
1. Provide a dowel bar splicer system only where one is shown on the Contract Drawings or where approved by the Program/Project Manager.
 2. Contractor shall provide only one Manufacture on the project for threaded type of splice systems.
 3. Provide a two-piece dowel bar splicer system manufactured from Grade 60 steel as specified in ASTM A615/A615M, and having a “dowel-in” piece consisting of a deformed rebar with the splice end externally-threaded so it can be threaded into the mating “dowel bar splicer” piece which consists of a deformed rebar equipped with an internally-threaded hole and integral nailing flange plate factory-forged onto the end of the bar.
 4. The strength of the completed splice must exceed the yield strength specified for Grade 60 steel rebar in ASTM A615/A615M as follows:
 - a. For building structures, exceed 160 percent of the yield strength specified.
 - b. For elevated guideway structures, exceed 125 percent of the yield strength specified.
 5. Where “dowel bar splicers” are provided for mating with “dowel-ins” to be installed later, install the manufacturer’s plastic internal coupler protectors in the “dowel bar splicers”.
 6. Provide solid plastic sleeves placed over the “dowel-in” ends to protect the threading from damage, contamination, and rust.
 7. Acceptable Manufacturers:
 - a. Dayton Superior Concrete Accessories, www.daytonsuperior.com.
 - b. ERICO International, Inc., www.erico.com.
 - c. Approved equal.
- C. Bar-Lock Coupler:
1. Provide a bar-lock coupler only where one is shown on the Contract Drawings or where approved by the Program/Project Manager.
 2. Provide bar-lock couplers having lock-shear bolts with internal serrated grip rails that splice with rebar mechanically.
 3. Provide each coupler with a removable center pin for easy referencing.
 4. The strength of the completed splice must exceed the yield strength specified for Grade 60 steel rebar in ASTM A615/A615M as follows:



- a. For building structures, exceed 160 percent of the yield strength specified.
 - b. For elevated guideway structures, exceed 125 percent of the yield strength specified.
5. Acceptable Manufacturers:
 - a. Dayton Superior Concrete Accessories, www.daytonsuperior.com.
 - b. Approved equal.
- D. Headed Deformed Bars:
 1. Provide a headed deformed bar system only where approved by the Program/Project Manager.
 2. Provide headed deformed bars complying with the requirements specified in ASTM A970; and do not allow obstructions or interruptions of the bar deformation, if any, to extend more than 2 bar diameters from the bearing face of the head.
 3. The strength of the headed deformed bar must exceed 160 percent of the specified yield strength of Grade 60 steel rebar specified in ASTM A615/A615M.
 4. Manufactures:
 - a. ERICO International, Inc., Lenton Couplers, ICC-ES Legacy Report ER-3967, www.erico.com.
 - b. Dayton Superior Corporation, Dayton/Richmond dowel bar splice systems, ICC-ES Legacy Report ER-4028, www.daytonsuperior.com.
 - c. Approved equal.
- E. Slab Joint Dowel Bars:
 1. To transfer shear forces at slab-on-grade joints, provide plain round dowel bars conforming to requirements of ASTM A663/A663M, Grade 70, 75, or 80; and which are not burred, roughened, or deformed out-of-round so slippage is not hindered.
 2. Coat the slab joint dowel bars with curing compound conforming to the requirements specified in Section 03300, Cast-In-Place Concrete, to render the surface of the bars bondless.
- F. Deformed Bar Anchors:
 1. Provide deformed anchors conforming to the requirements of ASTM A1064/A1064M, except with a minimum yield strength of 70 ksi and a minimum ultimate tensile strength of 80 ksi.
 - a. Provide low carbon steel anchors with the following composition:
 - 1) Carbon: 0.23 percent, maximum.
 - 2) Manganese: 0.90 percent, maximum.
 - 3) Phosphorus: 0.040 percent, maximum.
 - 4) Sulfur: 0.050 percent, maximum.
 2. Acceptable Manufacturers:
 - a. Nelson Stud Welding, Inc, Type D2L, www.nelsonstud.com.
 - b. Approved equal.



G. Metal Accessories:

1. Provide metal accessories in accordance with the requirements of the CRSI Manual of Standard Practice.

2.03 FABRICATION:

A. Shop Fabrication:

1. Fabricate reinforcement to the dimensions indicated on the Contract Drawings and within the tolerances given in ACI 315.
2. Bend steel reinforcement using the cold bending method.
 - a. Do not use bars with kinks or bends not indicated on the Contract Drawings.
 - b. Fabricate bar shapes in a manner that will not injure the material or lessen the member strength.
 - c. Use either a hand- or power-operated bending machine designed for bending reinforcing steel.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 - a. Notify the Program/Project Manager when manufacturing, fabrication, or mill testing of the items intended for the Work of this Section are to be performed.
2. The Testing and Inspection Agency or the City of Phoenix Testing Laboratory will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
 - a. The tests specified in Subparagraphs 2.04.A.3 through 2.04.A.9 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
 - b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
3. Deformed Carbon Steel Bar Reinforcement Tests:
 - a. Test Procedure:
 - 1) The following properties of the deformed and plain carbon steel bar reinforcement will be determined using the methods specified in ASTM A615/A615M:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the deformed and plain carbon steel bar reinforcement using the methods specified in ASTM A615/A615M.



- b. Acceptance Criteria:
 - 1) Deformed and plain carbon steel bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615/A615M, and that pass the bend test for the bar size, as specified in ASTM A615/A615M are acceptable.
- 4. Low-Alloy Steel Deformed Bar Reinforcement Tests:
 - a. Test Procedure:
 - 1) The following properties of the low-alloy steel deformed and plain bar reinforcement will be determined using the methods specified in ASTM A706/A706M:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the low-alloy steel deformed and plain bar reinforcement using the methods specified in ASTM A706/A706M.
 - b. Acceptance Criteria:
 - 1) Low-alloy steel deformed and plain bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified, and that pass the bend test for the bar size, as specified in ASTM A706/A706M are acceptable.
- 5. Steel Welded Wire Reinforcement Tests:
 - a. Test Procedure:
 - 1) The tensile strength, yield strength, and percent reduction of area will be determined, and the bend test for steel welded wire reinforcement will be performed in accordance with the methods specified in ASTM A1064/A1064M.
 - b. Acceptance Criteria:
 - 1) Steel wire used to fabricate the steel welded wire reinforcement that exhibits the tensile strength, yield strength, and percent reduction of area within the ranges specified, and that passes the bend test for the wire size as specified in ASTM A1064/A1064M are acceptable.
- 6. Deformed Bar Anchor Tests:
 - a. Test Procedure:
 - 1) The tensile strength and yield strength will be determined, and the bend test for steel deformed bar anchors will be performed in accordance with the methods specified in ASTM A496/A496M.
 - b. Acceptance Criteria:



- 1) Deformed bar anchors exhibiting the tensile strength and yield strength within the ranges specified in Subparagraph 2.01.E.1 are acceptable.
7. Dowel Bar Splicer System Tests:
 - a. Test Procedure:
 - 1) The following properties of the dowel bar used to fabricate the dowel bar splicer components will be determined using the methods specified in ASTM A615/A615M:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the dowel bar used to fabricate the dowel bar splicer components using the methods specified in ASTM A615/A615M.
 - b. Acceptance Criteria:
 - 1) Dowel bar splicer components that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615/A615M, and pass the bend test for the bar size as specified in ASTM A615/A615M are acceptable.
8. Dowel Bar Tests:
 - a. Test Procedure:
 - 1) The chemical composition, tensile strength, yield point, and percent elongation of slab joint dowel bars will be determined in accordance with the methods specified in ASTM A663/A663M.
 - b. Acceptance Criteria:
 - 1) Dowel bars exhibiting the tensile strengths, yield points, and percent's elongation within the ranges as specified in ASTM A663/A663M for the Grade of bar tested are acceptable.
9. Bar Lock Coupler Test:
 - a. Test Procedure:
 - 1) The yield strength of the bar lock coupler splice will be determined using the methods specified in ASTM A615/A615M:
 - b. Acceptance Criteria:
 - 1) Bar lock coupler splices that exhibit the yield strength meeting or exceeding the value specified in Subparagraph 2.01.C.4 are acceptable.

B. Non-Conforming Work:

1. Do not use concrete reinforcement that fails the testing.



PART 3 EXECUTION

3.01 INSTALLATION

A. Placing Concrete Reinforcement:

1. Place metal concrete reinforcement accurately and in accordance with ACI 318.
 - a. Do not lay metal reinforcement on formwork.
 - b. Terminate reinforcement 2 inches from the face of expansion joints.
 - c. Continue reinforcement across or through construction joints.
 - d. Place additional concrete reinforcement around openings in slabs and walls as detailed on the Contract Drawings.
 - e. Provide reinforcing accessories to securely brace the reinforcement against displacement outside of permitted tolerances.
2. Slab Reinforcement Placement:
 - a. Install welded wire reinforcement as indicated, lapping joints eight inches with the overlap being measured between the outermost cross wires of each reinforcement sheet and securely wiring the joints together.
 - b. Extend welded wire reinforcement to within 2 inches of sides and ends of slabs.
 - c. To support slab reinforcement from the ground, place the reinforcement on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of the concrete being placed.
 - 1) Use concrete blocks not larger than 3 inches by 3 inches and of a height equal to required bottom steel cover.
 - d. To support slab reinforcement from formwork, place the reinforcement on bar chairs made of plastic or metal.
 - 1) If the slab surface is exposed to view, provide supports with legs protected by plastic or stainless steel.
 - e. Field weld deformed bar anchors to slab edge steel bent plate as shown on the Contract Drawings.

B. Concrete Reinforcement Field Bends:

1. Do not field bend bars partially embedded in concrete.
2. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcement around it.
 - a. Do not bend the reinforcement to clear the obstructions.

C. Shortening Concrete Reinforcement:

1. Shorten (trim) concrete reinforcement, if required, by shearing or sawing.
2. Shortening concrete reinforcement using an acetylene torch may be acceptable, but only if the location of the shortening is approved by the Program/Project Manager in writing in advance.



- D. Welding Concrete Reinforcement:
 - 1. Do not weld concrete reinforcement except when using ASTM A706/A706M weldable reinforcement, and only where indicated in the Contract Documents or approved in writing by the Program/Project Manager.
 - a. Only weldable rebar as specified in Subparagraph 2.02.A.2 is permitted to be welded.
 - 2. Select proper filler materials, preheat temperatures, and performance/procedures in accordance with the requirements specified in AWS D1.4/D1.4M.
- E. Splicing Concrete Reinforcement:
 - 1. Splice reinforcement in accordance with ACI 318 and as indicated on the Contract Drawings.
 - a. Make mechanical butt splices in accordance with the manufacturer's installation instructions.
 - 2. Secure reinforcement at intersections with not less than 16 gauge annealed wire or appropriately sized clips.
 - a. Where bar spacing is less than 12 inches, tie alternate intersections.
 - b. Do not tack-weld crossing bars.
- F. Slab Joint Dowel Bar Installation:
 - 1. Install one-half the length of the coated bar dowel into the slab to be poured.
- G. Elevated Guideway Structures:
 - 1. For elevated guideway structures, comply with the additional concrete reinforcement requirements specified in Subsection 605-3 in the ADOT Standard Specifications for Road and Bridge Construction.

3.02 SITE QUALITY CONTROL

- A. Inspections:
 - 1. Notify the Program/Project Manager at least 10 days prior to scheduled concrete placement operations so he or she can inspect the placement of reinforcement, and to allow sufficient time for the code-required Approved Agency responsible for performing special inspections to schedule an inspection of the concrete reinforcement.
 - 2. Prior to placing concrete, inspect the reinforcement size, location, spacing, clear distance between bars and to the outside face of the concrete, and the reinforcement will not be displaced during the placement of concrete.
 - a. Verify the rebar splicer system is installed at the approved locations, is the correct type, and is installed in accordance with the manufacturer's guidelines.



3.03 CLEANING

- A. Clean or otherwise protect metal reinforcement so that at the time the concrete is placed, the reinforcement is free from rust, scale, or other coatings that could destroy or reduce the concrete to steel bond.

3.04 PROTECTION

- A. Provide protection for concrete reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.
- B. Protect in-place reinforcement from excessive construction traffic and other work.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.04.B.2, 2.01.B	Add requirements for ENVISION Sustainability Rating System
2	03/02/2018	N/A	1.02.C	Corrected Reference Standards
			All	Corrected ASTM References.





SECTION 03250

POST-TENSIONING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for furnishing, installing, stressing, and grouting tendons in post-tensioned concrete members at the locations shown on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 01400 - Quality Requirements.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. LRFD: Load and Resistance Factor Design, a system of structural analysis and design methodologies developed for bridges, with load and resistance factors based on the known variability of applied loads and material properties.
- B. Definitions:
 - 1. Functional Tendon Groups: Cantilever tendons, continuity tendons, draped external tendons, continuous profiled tendons passing through one or more spans, and similar tendon groupings.
 - 2. Post-Tensioning: A method of prestressing, used to reinforce concrete, masonry, and other structural elements, that induces internal stresses during the construction phase that are designed to counteract the external loads the member is anticipated to encounter during its life cycle.
 - 3. Tendon: A number of individual strands of a certain diameter or the diameter of a bar.
 - 4. Unbonded Tendons: Tendons generally located external to the concrete.
- C. Reference Standards:



1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO LRFD Bridge Design Specifications, 4th Edition, Customary U.S. Units, 2007.
 - b. AASHTO LRFD Bridge Design Specifications, 4th Edition, 2008 Customary U.S. Units Interim.
 - c. AASHTO M 203M/M 203 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement.
 - d. AASHTO Standard Specifications for Highway Bridges – HB-17.
2. American Concrete Institute (ACI):
 - a. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
3. ASTM International (ASTM):
 - a. ASTM A 416/A 416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - b. ASTM A 722/A 722M - Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
 - c. ASTM C 150 - Standard Specification for Portland Cement.
 - d. ASTM C 939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - e. ASTM C 940 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - f. ASTM C 942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - g. ASTM C 953 - Standard Test Method for Time of Setting of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - h. ASTM C 1090 - Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout.
4. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. Post-Tensioning Institute (PTI):
 - a. PTI Acceptance Standards for Post-Tensioning Systems.
 - b. PTI Bonded Post-Tensioning Installer.
 - c. PTI Level 1 Field Fundamentals of Unbonded Tendons Workshop.
 - d. PTI Post-Tensioning Manual.
 - e. PTI Specification for Grouting of Post-Tensioned Structures.
7. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Notify everyone at the Site when stressing operations are scheduled to occur.
2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing and inspections performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
3. Before concrete is to be placed, coordinate work that must support or be embedded in the concrete to allow embedded items to be introduced or furnished before the concrete is placed and not delay the Work.

B. Pre-Installation Meetings:

1. Prior to installing post-tensioning tendons, convene an onsite meeting to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of the post-tensioned concrete elements.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Sheathing material type and thickness.
 - 2) Pre-packaged grout.
 - b. Shop Drawings:
 - 1) Fabrication and placement details.
 - 2) Proposed post-tensioning method and equipment.
 - c. Certificates:
 - 1) Certified copies of mill test reports for post-tensioning steel material.
 - 2) Jack and gauge unit calibration certificates.
 - d. Delegated Design Submittals:
 - 1) Design calculations.
 - 2) Job-site grout mix.
 - e. Special Procedure Submittals:
 - 1) Grouting Operation Plan.
 - f. Qualification Statements:
 - 1) Post-tensioning technicians' qualifications.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Stressing Records.
 - 2) Grouting Report
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.

B. Qualifications:

1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
3. Stressing Crew Qualifications:
 - a. Individuals proposed for post-tensioning technicians who will be performing the post-tensioning operations must as a minimum be certified by an independent training certification program such as that provided for Level 1 certification by the Post-Tensioning Institute (PTI).
 - b. Submit copies of the certification for post-tensioning technicians who will use the proposed system.



4. Professional Engineer Qualifications:
 - a. Employ a licensed Professional Engineer, registered in the State of Arizona, having experience performing post-tensioning calculations.

C. Certifications:

1. Certified Post-tensioning Steel Mill Tests:
 - a. For post-tensioning steel material, submit certified copies of mill test reports to the Program/Project Manager that, as a minimum, contain the following information for approval:
 - 1) Heat number and identification.
 - 2) Standard chemical analysis for heat of steel.
 - 3) Ultimate tensile strength.
 - 4) Yield stress at 1 percent extension under load.
 - 5) Elongation of failure.
 - 6) Modulus of elasticity.
 - 7) Diameter and net area.
 - 8) Type of material.
2. Jack and Gage Calibration Certificates:
 - a. Submit a calibration certificate for every jack and gage unit being furnished.
 - 1) Pair each jack with a particular gage, and keep them together as a unit.
 - 2) Calibrate each jack and gage pair together as a unit.
 - b. Calibrate equipment against known standards at intervals not exceeding 6 months.

D. Preconstruction Testing:

1. Have the Job-Site Grout Mix tested in accordance with the methods specified in Subparagraph 2.03.A.2 and approved by the Program/Project Manager prior to preparing production batches.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Delivery Requirements:
 - a. Post-tensioning Steel:
 - 1) Suitably wrap, package, and cover post-tensioning steel at the factory to prevent physical damage during transportation and from deleterious corrosion.
 - 2) Clearly identify the grade, coil, heat number, and type on the packs or coils.
 - b. Maintain a record of all delivered materials, and make it available to the City Representative, the Program/Project Manager, and Inspectors upon request.
2. Acceptance Requirements:



- a. Have the post-tensioning installer inspect post-tensioning steel and all accessories at the time of delivery to the Site and prior to placement.
 - 1) Notify the Program/Project Manager of observed damages immediately.
 - b. Surface Condition:
 - 1) Pits on steel strand surfaces shall not exceed 0.002 inches in diameter or length.
 - 2) If surface rust is present, remove it with a fine steel wool pad or by vigorously rubbing it with a cloth.
 - c. Remove and discard lengths of strands containing broken or corroded wires.
- B. Storage and Handling Requirements:
- 1. Duct:
 - a. Store duct coils in dry location on raised platform.
 - b. Cover duct coils to prevent introduction of contaminants into the duct.
 - 2. Grout:
 - a. Store grout related materials on a raised, dry platform with adequate weatherproof covering.
 - b. Prior to using materials, verify they have not exceeded the shelf life listed by the manufacturers.
 - 3. Post-tensioning Steel:
 - a. Keep post-tensioning steel dry.
 - 1) Place post-tensioning steel stored at the Site above the ground on elevated covered platforms.
 - 2) Do not expose post-tensioning steel materials to water and/or dirt.
 - b. Do not expose post-tensioning steel materials stored more than one month to direct sunlight.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
- 1. Take precautions to minimize exposure of tendons to weather and on-site conditions that may promote corrosion.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA:

- A. Sustainability Requirements:
- 1. ENVISION Requirements:
 - a. Recycled Content
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement



indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

- B. Comply with provisions of the following codes, specifications, and standards except where more stringent requirements are specified:
 - 1. PTI Post-Tensioning Manual.
 - 2. Section 602, Prestressing Concrete, in the ADOT Standard Specifications for Road and Bridge Construction for elements supporting the elevated guideway structure.
 - 3. AASHTO LRFD Bridge Design Specifications.
 - a. Allowable design stresses on the concrete cannot exceed values obtained following procedures defined in the AASHTO LRFD Bridge Design Specifications.
 - 4. ACI 318/318R.
- C. Anchorage and Coupling Capacities:
 - 1. Anchorages must be capable of developing at least 95 percent of the actual ultimate strength of the post-tensioning steel in accordance with the requirements of the Post-Tensioning Institute (PTI) specifications.
 - 2. The anchorage device must be capable of holding the post-tensioning steel without exceeding the anticipated set under a load producing a stress of not less than 95 percent of the guaranteed minimum tensile strength of the post-tensioning steel.
 - 3. Anchorages and couplings must be capable of fully developing the minimum guaranteed ultimate strength of tendons without excessive slip.
- D. Local Zone (Confinement) Reinforcing:
 - 1. The post-tensioning system Supplier is responsible for designing the local zone (confinement) reinforcing.
- E. Calculations:
 - 1. Prepare detailed design calculations, signed and sealed by the Professional Engineer, which include the following:
 - a. The elongation of the tendons at the time of jacking
 - b. The initial forces in the tendons.
 - c. The final working force.
 - d. The stresses in the anchorages and the distribution plates.
 - 2. Submit the design calculations to the Program/Project Manager for approval.
- F. Shop Drawings:
 - 1. Prepare Shop Drawings, signed and sealed by the Professional Engineer, that include the following information:
 - a. Fabrication and placement details showing the following:
 - 1) Details and dimensioned layout of tendons.
 - 2) Tendon sizes.



- 3) Type of post-tensioning duct.
 - 4) End anchorages.
 - 5) Coupler details.
 - 6) Corrosion protection materials, details, and application limits.
 - 7) For internal post-tensioning only, details of grout inlet and outlet fabrication, and inlet and outlet locations along the ducts.
 - b. Describe the proposed post-tensioning method and equipment, including the tensioning sequence, the type of pressure-monitoring devices, anchorages, tendon elongation, and tendon cutoff.
 - c. Submit the Shop Drawings to the Program/Project Manager for approval.
- G. Grouting Operation Plan:
 1. Provide a written Grouting Operation Plan addressing procedures for mixing, pumping, duct cleaning, and if required, re-grouting.
 - a. Include procedures to be implemented if leaks are observed in the ducts.
 2. Submit the Grouting Operation Plan to the Program/Project Manager for approval.

2.02 MATERIALS

- A. Ducts:
 1. Select ducts based on the recommendations for sheathing materials in the PTI Post-Tensioning Manual.
 2. Sheathing Material:
 - a. Provide ducts manufactured from ferrous metal, high-density polyethylene (HDPE), or polypropylene (PP).
 - 1) Provide material that is nonreactive with concrete, post-tensioning steel, and reinforcement steel.
 - 2) Provide material capable of preventing cement paste from the surrounding concrete entering into the duct.
 - 3) Provide material strong enough to retain its shape and to resist un-repairable damage during construction.
 - 4) Provide smooth plastic duct for external post-tensioning systems.
 - b. Provide rigid galvanized ferrous metal ducts for use on elevated guideway support members.
 - c. Submit Product Data for the sheathing material indicating its type and thickness.
 3. Post-tensioning Duct Size:
 - a. Provide post-tensioning ducts having an inside cross sectional area at least 2 times greater than the net area of the post-tensioning strand, or inside diameter 0.25 inches larger than the outside diameter of the post-tensioning bar.
 4. Grout Inlet and Outlet Vents for Internal Post-Tensioning:



- a. For internal post-tensioning only, provide grout inlet and outlet vents of sufficient diameter to allow the free-flow of grout into, and to allow air, water, and bleed-water to escape from ducts.
 - b. Provide shut-off valves or other approved positive means of closing grout inlet and outlet vents.
 5. Sealing:
 - a. Provide positively sealed connections between the post-tensioning duct and the anchor assembly, between the prestressing ducts and the deviation pipes, and between spliced sections of duct.
- B. Post-Tensioning Steel:
 1. Strands:
 - a. Provide post-tensioning tendons fabricated from steel complying with the requirements for Grade 270 Low Relaxation Strand specified in AASHTO M 203M/M 203 (ASTM A 416/A 416M).
 2. Bars:
 - a. Provide high strength steel bars complying with the requirements of ASTM A 722/A 722M, including Supplementary Requirements S1 and S2.
 - b. Tensile Strength (Minimum): 150 ksi.
 3. Manufacturers:
 - a. Manufacturer List:
 - 1) Arizona Post Tension, Inc., Telephone: (520) 623-2624.
 - 2) Post Tension of Nevada, Inc., Telephone: (602) 353-1577.
 - 3) Pulte Building Systems, Telephone: (623) 907-3340.
 - 4) Southwest Post-Tension Systems, Inc., Telephone: (602) 262-2253.
 - 5) Suncoast Post-Tension, Ltd., Telephone: (602) 279-2763.
 - 6) Approved equal.
- C. Anchorages and Couplings:
 1. Fabricate anchorages and couplings from metal compatible with the stressing reinforcement and having proven corrosion resistance.
 2. Anchorages:
 - a. Provide button-head, wedge, nut and thread, grip nut, thread-bar, threaded plate, or other approved type anchorages.
 - b. Provide anchorages with bearing plates, bars, rings, bells, or another positive attaching anchor fitting.
 3. Couplings and Fittings:
 - a. Provide couplings with a housing long enough to permit the movement necessary, and for internal post-tensioning only provide fittings which allow complete grouting of all components.
- D. Deviation Pipes:
 1. Provide smooth, steel deviation pipes bent to the radii indicated on the Contract Drawings.



- E. Pre-Packaged Grout:
 - 1. Provide pre-packaged, cement-based, nonmetallic, nonshrink fluid grout specially formulated for grouting cables and tendons.
 - 2. Submit Product Data for the pre-packaged grout to the Program/Project Manager for approval prior to using the grout.
 - 3. Acceptable Manufacturers:
 - a. Five Star Products, Inc., Five Star® Special Grout 400, www.fivestarprouducts.com
 - b. The Euclid Chemical Co., Euco Cable Grout PTX, www.euclidchemical.com.
 - c. Sika Corporation, SikaGrout® 300 PT, www.sikaconstruction.com.
 - d. Or approved equal.
- F. Corrosion Inhibiting Grease:
 - 1. Provide a corrosion inhibiting grease complying with the requirements of the post-tensioning manufacturer.

2.03 MIXES

- A. Job-Site Grout Mix:
 - 1. Job-Site Grout Materials:
 - a. Provide a job-site grout mix consisting of mixture of Portland cement, a shrinkage compensating admixture, and potable water.
 - 1) Portland Cement:
 - a) Provide Type I or II Portland cement complying with the requirements of ASTM C 150.
 - 2) Admixture:
 - a) Provide shrinkage compensating admixture complying with the requirements of ASTM C 940, and exhibiting a 2 percent minimum and 6 percent maximum unconfined expansion.
 - b) Do not provide material containing aluminum powder, chlorides, fluorides, sulfites, and/or nitrates.
 - b. Water Cement Ratio:
 - 1) Provide the minimum Water Cement Ratio necessary for proper placement; but not exceeding 0.45.
 - 2. Job-Site Grout Performance:
 - a. Compressive Strength: 3000 psi at 7 days and 5000 psi at 28 days when tested according to ASTM C 942.
 - b. Set Time: Greater than 3 hours, but less than 12 hours, when measured according to ASTM C 953.
 - c. Volume Change: 0.0 percent to less than 0.1 percent at 24 hours, and no more than 0.2 percent at 28 days when measured according to ASTM C 1090.
 - d. Pumpability: Efflux time immediately after mixing between 11 and 30 seconds when measured according to ASTM C 939.



3. Submit the job-site grout mix to the Program/Project Manager for approval.

2.04 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 2. The Testing and Inspection Agency or the City of Phoenix Testing Laboratory will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
 - a. The tests specified in Subparagraphs 2.04.A.3 through 2.04.A.4 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
 - b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
 3. Duct Sheathing Strength Test:
 - a. Test Procedure:
 - 1) Determine the strength of the sheathing in accordance with Section 5, Sheathing, of the PTI Acceptance Standards for Post-Tensioning Systems.
 - b. Acceptance Criteria:
 - 1) Submit test data showing the sheathing has sufficient strength to withstand damage during installation and concrete placement in accordance with Section 5, Sheathing, of the PTI Acceptance Standards for Post-Tensioning Systems.
 4. Duct Sheathing Durability Test:
 - a. Test Procedure:
 - 1) Determine the durability of the sheathing in accordance with Section 5, Sheathing, of the PTI Acceptance Standards for Post-Tensioning Systems.
 - b. Acceptance Criteria:
 - 1) Submit test data showing the sheathing has sufficient durability to withstand damage during installation and concrete placement in accordance with Section 5, Sheathing, of the PTI Acceptance Standards for Post-Tensioning Systems.

PART 3 EXECUTION

3.01 INSTALLERS

- A. Installation and stressing of tendons must be performed by individuals certified by an independent training and certification program as provided by the Post-Tensioning Institute (PTI). Evidence of such certification must be presented to



the Special Inspector on site prior to the performance of any post-tensioning stressing operations.

3.02 PREPARATION

- A. Take measures to notify everyone at the Site that a stressing operation will be occurring.
 - 1. Implement a warning system in place, such as flashing lights or red flags, to indicate stressing operations are in progress.

3.03 INSTALLATION

- A. Installing Deviation Pipes:
 - 1. Locate and cast the deviation pipes in the concrete beams as shown on the Contract Drawings.
 - a. Clean and deburr the deviation pipes to prevent damage to the post-tensioning tendons.
- B. Installing Duct:
 - 1. Place duct enclosures for post-tensioning steel at the locations shown on the Contract Drawings.
 - 2. For internal post-tensioning only, securely fasten the ducts in place to prevent their movement and displacement during concrete placement.
 - a. Do not allow the duct support spacing to exceed the values given in the Post-Tensioning Institute Manual.
 - 3. Verify the ducts are mortar tight.
 - 4. After the ducts are installed, keep the ends of the duct covered to prevent entry of water or debris.
- C. Installing Post-tensioning Steel:
 - 1. If the post-tensioning steel is installed after the concrete has been placed, demonstrate the ducts are free of water and debris prior to installing the tendon strands.
 - 2. Develop a strand placement plan to prevent steel from collecting foreign matter.
 - a. Verify the post-tensioning steel is clean when placed into the ducts.
 - 3. For all externally post-tensioned tendons, apply a corrosion inhibiting grease to the tendons to act as a corrosion protection system.
 - 4. Secure the post-tensioning steel at its ends using an approved permanent type anchoring device.
 - 5. Provide an approved device that effectively distributes the load on the anchoring device to the concrete.
- D. Post-Tensioning Tendon Strands:
 - 1. Furnish an experienced trained crew to properly stress the tendon strands with an Inspector present during entire stressing operation.



2. Do not begin the stressing operation before verifying the ducts are clean and dry.
3. Fit the jacking system with a pressure gauge; calibrate the jacking system and pressure gauge together, and keep the two together as a unit.
 - a. Calibrate the stressing jack and gauge immediately prior to use.
 - b. Furnish a certified calibration chart for the jack and gauge.
4. Prior to beginning the jacking operation, verify the anchorage is aligned and properly supported so uniform bearing on concrete is assured, and verify local and general zone reinforcement was provided.
5. Do not tension the tendon strands until both the required concrete compressive strength has been achieved and 7 calendar days have passed since last concrete was placed.
6. Tension the tendons as indicated on the approved Shop Drawings . For multi-span beams jacking of the tendons is to be done at each end of the tendon. For single-span beams, jacking of the tendons may be done from one end only.
7. Stress the tendons in the sequence shown on the approved Shop Drawings.
 - a. Jack the post-tensioning steel in 2 increments as follows:
 - 1) First, apply a small initial stress to straighten the post-tensioning steel, to eliminate slack, and to provide a reference point for measuring the elongation, as indicated on the approved Shop Drawings.
 - 2) Second, apply the final tension and measure strand elongations.
 - b. Do not allow the maximum temporary stress (jacking stress) to go above 81 percent of the minimum ultimate tensile strength of the post-tensioning steel.
8. Measure and record the jacking forces applied to all post-tensioning steel.
 - a. Conduct the tensioning process to allow the force being applied and the elongation of the post-tensioning steel to be measured at all times.
 - b. Record elongations at the intermediate and final stressing stages indicated on the approved Shop Drawings, or at the following intermediate and final gauge readings:
 - 1) 20 percent.
 - 2) 50 percent.
 - 3) 100 percent.
9. Verify the wedge seating measurement is consistent with the amount assumed in the approved Shop Drawings and Calculations. Make adjustments to the required jacking stresses and corresponding elongations to accommodate any differences between these two amounts as directed by the post-tensioning system supplier.
10. If the jacking forces and elongations are satisfactory and acceptable to the Program/Project Manager, cut off the ends (tails) of the post-tensioning steel strands only after direction from the Program/Project Manager.



- a. Protect strand tails until the Program/Project Manager approves cutting them off.
 - 1) A cutting torch is NOT an acceptable means for cutting post-tensioning steel strands.
- 11. Permanently protect the anchorage and anchor fittings against corrosion.
- E. Grouting Equipment:
 - 1. Grout Mixing Equipment:
 - a. Furnish mechanical mixing equipment capable of continuously mixing and pumping grout to provide a uniform, thoroughly blended grout.
 - b. Furnish grout equipment capable of placing grout at a pressure of at least 150 psi but not greater than 250 psi.
 - 1) Furnish grout equipment with an accurate pressure gauge.
 - 2) Prevent the introduction of oil, air, and other foreign substances into the grout.
 - 3) Prevent the loss of grout and water.
 - 2. Standby Flushing Equipment:
 - a. Furnish standby flushing equipment at the Site to flush out partially grouted ducts when necessary.
 - b. Furnish standby flushing equipment capable of providing dry, oil-free compressed air for removing water from the ducts, and for checking the passageway of the duct.
 - 3. Grout Injection and Ejection Pipes:
 - a. Fit grout injection pipes and ejection pipes with positive mechanical shutoff valves.
- F. Placing Grout:
 - 1. Prior to grouting post-tensioning ducts, fill the ducts with compressed air to verify if any duct connections, joints, or fittings require sealing or repair.
 - 2. Clean all ducts so they are free of deleterious materials that would impair the bonding of the grout or could interfere with grouting procedures.
 - 3. Verify all tendons are fully tensioned and anchored prior to any grouting operation.
 - 4. Prior to introducing grout into the pumping equipment, pass the grout through a screen having clear openings less than 1/8-inch in size.
 - 5. After steel installation, grout each duct before the time limit defined in Section 4.4.6.5 in the PTI Post-Tensioning Manual expires.
 - a. When grouting begins, open all vents in the duct.
 - b. Allow grout to flow only in one direction.
 - c. Do not add water to improve fluidity.
 - d. Once the steady flow of grout without residual water or air is maintained close intermediate vents.
 - e. Continuously waste the grout at the outlet until no visible slugs of air or water are ejected.
 - f. Maintain a minimum pressure of 75 psi for one minute in pressurized duct.



- g. Maintain the grout temperature between 50 degrees Fahrenheit and 90 degrees Fahrenheit.
 - 1) If hot weather conditions could contribute to quick stiffening of the grout, implement approved methods to avoid pump blockage.
 - 2) If freezing conditions will occur during or after grout placement, take appropriate measures to protect the grout from freezing.
6. If a leak is detected in the duct, seal the leaks as outlined in the approved grouting plan.

G. Tolerances:

1. Place ducts within plus or minus 1/4 inch of the dimensions shown on the approved Shop Drawings.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when concrete is being post-tensioned, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspections.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Site Tests:
 - a. Production tests on the grout mix to be placed will be performed as follows:
 - 1) Wick Induced Bleed Test:
 - a) Test Procedure:
 - (1) Perform one test per day in accordance with a modified version of the test method specified in ASTM C 940 to record bleed water above the grout.
 - (a) Immerse a 20-inch length of AASHTO M 203M/M 203 (ASTM A 416/A 416M) seven wire 0.5-inch diameter strand into a cylinder of the grout mix.
 - b) Acceptance Criteria:
 - (1) An acceptable bleed value for the grout is 0.0 percent after 3 hours of normal room temperature (70 degrees Fahrenheit).
 - 2) Strength Test:
 - a) Test Procedure:



- (1) Perform one test per day in accordance with the methods specified in ASTM C 942.
 - b) Acceptance Criteria:
 - (1) Grout whose strength is 3000 psi at 7 days and 4000 psi at 28 days is acceptable.
- 3) Fluidity (Flow Cone) Test:
 - a) Test Procedure:
 - (1) Perform one test every 2 hours during grouting operations in accordance with the methods specified in ASTM C 939.
 - b) Acceptance Criteria:
 - (1) Grout whose efflux time immediately after mixing is between 11 and 30 seconds is acceptable.
- 4) Volume Test:
 - a) Test Procedure:
 - (1) Perform one test per day in accordance with the methods specified in ASTM C 1090.
 - b) Acceptance Criteria:
 - (1) Grout whose volume change is 0.0 percent to less than 0.1 percent at 24 hours, and no more than 0.2 percent at 28 days is acceptable.
- b. Production tests on the tendons will be performed by the Contractor and observed by the Special Inspector as follows:
 - 1) Elongation Test:
 - a) Test Procedure:
 - (1) Compare the actual obtained elongation of the tendon with the theoretical calculated elongation as indicated on the approved Shop Drawings.
 - b) Acceptance Criteria:
 - (1) Tendon elongations that differ less than or equal to 5 percent from those indicated on the approved Shop Drawings are acceptable.
 - (2) If the tendon elongations differ by more than 5 percent, check the entire operation, determine the source of error, and correct the problem prior to proceeding with the Work as directed by the post-tensioning system Supplier and approved by the Program/Project Manager.
 - 2) In-Place Friction Test of Tendons:
 - a) Test Procedure:
 - (1) For tendons longer than 100 feet, a minimum of 1 tendon in a functional tendon group performing the same function will be tested in place.
 - (a) The tendon selected will be representative of the size and length of the functional tendon group being tested.



- (2) The tendon will be stressed at an anchor assembly with a load cell or second certified jack at the dead end in 8 equal increments up to 80 percent of the specified ultimate tendon strength.
 - (a) The gage pressure, elongation, and load cell force will be recorded for each increment.
 - (b) Wedge seating in both the live end (back of jack) and dead end (back of load cell), and friction within the anchorages, wedge plates, and jack resulting from slight deviations of the strands passing through these assemblies will be taken into account.
 - (c) For long tendons requiring multiple jack pulls with intermediate anchoring, the elongation at the jacking end will be accurately measured allowing for intermediate wedge seating and slop from the jack's wedges.
- b) Acceptance Criteria:
 - (1) Tendon elongations that differ less than or equal to 5 percent from those indicated on the approved Shop Drawings are acceptable.
 - (2) If measured elongations are outside the range of the anticipated theoretical elongation plus or minus 5 percent, generate detailed calculations to confirm the final tendon forces are in agreement with the Contract Drawings and approved Shop Drawings, and determine reasons for the discrepancy.
 - (3) When reconciling theoretical versus actual elongations, do not vary the expected friction and wobble coefficients by more than plus or minus 10 percent.
 - (4) Significant elongation shortfalls are indicative of poor duct alignments and/or obstructions.
 - (5) At least 1 successful friction test for each tendon group is required or the tendons are unacceptable.
 - (6) If there are irreconcilable differences between forces and elongations or other difficulties during the stressing operations, the Program/Project Manager may require additional friction tests be performed by the Contractor.
- 3) Dynamic Testing of Unbonded Tendons:
 - a) Test Procedure:
 - (1) Notify the Program/Project Manager at least 2 weeks prior to the proposed test date.
 - (2) For unbonded superstructure tendons, 2 dynamic tests will be performed on a representative specimen.



- (a) Furnish a test tendon that duplicates the behavior of the full size tendon, and that does not have less than 10 percent of the capacity of the full size tendon.
 - (b) The specimen for the second test does not need to be the same specimen used for the first test.
 - (c) For systems using multiple strands, wires, or bars, use a full size test tendon.
 - (3) The first test will subject the tendon to 500,000 cycles from 60 percent to 66 percent of its minimum specified ultimate strength.
 - (4) The second test will subject the tendon to 50 cycles from 40 percent to 80 percent of its minimum specified ultimate strength.
 - (5) Each period of each cycle will subject the tendon to the lower stress level up to the upper stress level and back to the lower stress level specified.
 - b) Acceptance Criteria:
 - (1) The tested tendon must withstand 500,000 cycles from 60 percent to 66 percent of its minimum specified ultimate strength without failure.
 - (2) In lieu of having the dynamic testing performed, the Contractor may submit data from prior successful dynamic tests for approval by the Program Manager.
3. Inspections:
- a. Continuous Special Inspections will be performed during the entire tendon placement, and stressing and grouting operations.
 - b. Stressing Records:
 - 1) The Contractor performing the post-tensioning operations will compile complete post-tensioning operation records that include the following information:
 - a) Project and Contract name.
 - b) Date of installation.
 - c) Post-tensioning tendon location.
 - d) Required tendon elongation.
 - e) Gauge pressure to achieve elongation.
 - f) Actual elongation achieved.
 - g) Actual gauge pressure.
 - h) Serial or identification number of the jacking equipment.
 - i) Weather conditions.
 - j) Name and signature of stressing operator.
 - 2) Within 48 hours of completion, submit complete post-tensioning operation records to the Program/Project Manager for approval and acceptance.
 - c. Grouting Report:



- 1) The Contractor performing the post-tensioning operations will compile a report on tendon grouting that includes the following:
 - a) Identification of the tendon grouted.
 - b) Date tendon was stressed and grouted.
 - c) Type of grout (site mixed or pre-packaged).
 - d) Length of grouting operation.
 - e) Grouting pressure.
 - f) Quality of grout used.
 - g) Summary of problems with grouting, if any; and corrective action taken if required.
 - h) Field test results.
- 2) Within 72 hours of completion, submit the Grouting Report on tendon grouting to the Program/Project Manager for approval and acceptance.

B. Non-Conforming Work

1. Permissible wire breakage in a strand is limited to 2 percent maximum.
2. When there is a significant shortfall between the actual elongation and the theoretical value, and the acceptance criteria indicated herein is not met, make corrections or compensations for such shortfall as proposed by the post-tensioning system Supplier and approved by the Program/Project Manager. The Contractor is responsible for resolving such shortfalls and non-conforming Work to the satisfaction of the Program/Project Manager at no increase in the Contract Price.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition





SECTION 03260

GABION RETAINING WALL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for constructing metal gabion retaining walls.
- B. Related Requirements:
 - 1. PSHIA - Submittal Procedures.
 - 2. PSHIA - Quality Requirements.

1.02 REFERENCES

- A. Reference Standards:
 - 1. American Institute of Steel Construction, Inc. (AISC):
 - 2. ASTM International (ASTM):
 - a. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement.
 - b. ASTM A82 - Standard Specification for Steel Wire
 - 3. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit.
 - 3) Dust Control Logs.
 - 4) Burn Permit Application,
<http://www.maricopa.gov/aq/divisions/compliance/dust/docs/pdf/BURN-APP2.pdf>.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
 - 2) Regulation III – Control of Air Contaminants:
 - a) Rule 300 – Visible Emissions,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/300-0803.pdf.



- b) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
- c) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Before construction of the Gabion Retaining Walls contractor shall build mockup of Gabion Wall per Section 01454 and gain approval from PSHIA staff.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required approvals of the mockup wall work.
- B. Pre-Installation Meetings:
 - 1. Prior to placement of any of the gabion retaining walls, convene an onsite meeting with PSHIA staff to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
 - 2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of the gabion retaining wall features.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of PSHIA, Submittal Procedures:
 - a. Product Data:
 - 1) Gabion Basket Hilfiker ArtWeld Gabions (welded wire mesh)
 - b. Shop Drawings:
 - 1) Schedule showing proposed construction methods, and the sequence of wall work effort.
 - c. Samples:
 - 1) Samples of materials being used when requested.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of PSHIA, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Hilfiker ArtWeld Gabions (welded wire mesh) accessories installation instructions.

C. Closeout Submittals:

1. Submit the following to the Construction Manager in accordance with the requirements of PSHIA, Closeout Submittals:

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Dust Control Permit:
 - a. Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.

B. Site Samples:

1. Submit Samples of materials being used when requested by the Program/Project Manager, including the Samples' names, sources, and descriptions.

C. Mock-Ups:

1. Mock-ups are required for gabion retaining walls see Section 01454.
 - a. Do not incorporate mock-ups into the final work.
 - b. Provide a mock-up showing the finished wall work for gabion materials, rock fill color for exposed rock surfaces not less than 3 feet by 3 feet in size.
 - 1) Furnish the number of mock-up panels necessary to obtain the approval of the basket material and final rock color.
 - 2) Approved mock-ups will serve as the standard for the aesthetic quality of the surface finish, and be called the Control Sample.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

- a. A Certificate of Compliance shall accompany each shipment of gabions to a job site provide this certificate to PSHIA Program/Project Manager for review and approval.
- b. Gabion Baskets delivered to the site are to be stored by the Contractor at the established staging area.

B. Storage and Handling Requirements:

1. Store gabion baskets so contamination, evaporation, moisture penetration, and damage is prevented.



PART 2 PRODUCTS

2.01 GABIONS

1. Gabions: shall be of a single unit construction. Gabions shall be welded wire non-galvanized mesh basket of a single unit of construction. The bottom mat, sides, dividers, back face, front face, shall be connected and spiraled into rectangular baskets of the specified sizes. The non-galvanized welded wire mesh baskets shall be Hilfiker Retaining Walls Artweld Gabion 1-800-762-8962 or approved equal. Contractor shall provide samples of welded wire mesh baskets to the Program/Project Manager at least 30 days in advance of the time when its use is expected to begin.

The base, ends, sides, and lid shall be fabricated from 3"x3" 9 Gauge Black Welded Wire Mesh and connected in such a manner that strength and flexibility at the connection are at least equal to that of the wire mesh. The gabions shall be fabricated in such a manner that they can be assembled at the construction site with Spiral Binders and pre-formed stiffeners to form rectangular baskets of the specified size. The height, length, and width of the gabions shall not vary more than 5 percent from the dimensions shown on the plans. Gabions shall be divided into cells of equal length, not more than 3 feet long, by diaphragms made of the same wire mesh as used for the gabion body. Each gabion shall be fabricated with the necessary diaphragm or diaphragms secured in proper position on the base in such a manner that no additional tying at the base will be necessary.

2. Wire for the manufacture and assembly of gabions shall meet or exceed all of the following requirements:

Description	Requirement
3"x3" (9 ga. - 0.144 in. min.) Welded Wire Fabric	ASTM A185
9 ga. Pre-Formed Stiffener	ASTM A82
9 ga. Spiral Binder	ASTM A82

3. Rock for filling the gabions shall be approved in advance by PSHIA Program/Project Manager and shall be a color as listed on the drawings but shall be in compliance with the following gradation requirements:

100% passing 8 inches (20.3 cm), 0-5% passing 4 inches (10.2 cm)



Rock for the baskets shall conform to the requirements of MAG Section 703 and shall match the color and gradation as called for on the project plans. Rock shall be sound and durable, free from clay or shale seams, cracks or other structural defects. The Bulk Specific gravity (SSD) shall be determined in accordance with the requirements of AASHTO T 85 and shall be a minimum of 2.4. Rock used to fill the welded wire mesh baskets rock shall be well graded varying from four inches minimum to nine inches maximum in size. Rock shall have the following gradation: D50 =6", DMax=9", DMin=4". Control for the gradation will be by visual inspection of the Engineer.

PART 3 EXECUTION

3.01 FOUNDATION PREPARATION

- A. The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundation surface area. When fill is required, it shall consist of materials conforming to the specified requirements. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed, and the subgrade surfaces have been inspected and approved by the PSHIA Program/Project Manager. Bedding material for the baskets that will create the benches on natural grade shall consist of native earth scarified to a depth of one foot and compacted to 95% density. Bedding material for Gabion Basket Retaining walls shall consists of 12 inches Aggregate Base Materials in Compliance with MAG Section 702 placed over native earth compacted to a 95% density. The bedding shall be free of clay or organic material.
- B. Compaction of bedding or filter material will be required per plans and specifications. The surface of the finished material shall be to grade and free of mounds, dips or windrows. Extra care should be taken with foundation preparations in order to ensure a level and smooth surface. Geotextile shall be installed in accordance with the requirements of the plans and specifications.

3.02 ASSEMBLY AND PLACEMENT

- A. Gabions shall first be assembled individually as empty units. Each gabion shall be manufactured with the necessary panels, properly spaced and secured, so they can be rotated into position at the construction site with no additional tying of the rotation joint. The panels and diaphragms shall be rotated into position and joined along vertical edges. Temporary Hog Ring fasteners may be used for preassembly to connect panels. Welded wire mesh baskets shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into geometric or semi-circular units of specified sizes. Welded wire mesh baskets are to be of single unit of



construction, the base ends and sides to be welded or physically connected into a single unit or one edge of these members connected to the end section of another unit in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh. The height, length, and width of welded wire baskets shall not vary more than 1 percent from the dimensions shown on the plans.

All perimeter edges of welded wire mesh baskets are to be securely selvedge or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

- B. Use 9-gauge spiral binders to connect all diaphragms and lids, the spiral shall be screwed into position such that it passes through each mesh opening along the joint. One end of all 9-gauge spiral binders shall be crimped to secure the spiral in place. Temporary fasteners may remain in place.
- C. Assembly of Successive Gabions (Gabion to Gabion Joints):
 - 1. The construction sequence for welded wire baskets shall require placement of the bottom basket and 95% compaction adjacent the basket. Once the first layer of baskets has been placed, filled, compacted, and approved by the Engineer the second layer may be constructed. This process will be repeated until the entire height of welded wire baskets has been completed.
 - 2. Empty gabions shall be set in place. Individually constructed empty gabions shall be joined successively to the next empty gabion with 9-gauge spirals, before filling with rock begins. The 9-gauge spiral binders shall secure, in one pass, all selvedge or end wires of panels of all the adjacent gabions along the joint.
 - 3. All welded wire mesh baskets shall be tied together each to its neighbor along all contacting edges in order to form a continuous connecting structure.

3.03 CONSTRUCTION

- A. Filling With Rock:
 - 1. The gabions shall be carefully filled with rock, either by machine or hand methods, ensuring alignment, avoiding bulges, and providing a compact mass that minimizes voids. At no point in the filling process may rock be mechanically placed from a height of over 36" from machine to fill area. Machine placement will require supplementing with handwork to ensure the desired results. The cells in any row shall be filled in stages so that the depth of rock placed in any one cell does not exceed the depth of rock in any adjoining cell by more than 12 inches. Along the exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat, compact placement with a uniform appearance.



- a. When constructing with 1.5-foot high or 3-foot high gabions, pre-formed stiffeners shall be used to produce a flat, smooth external surface.
- b. Pre-formed Stiffeners shall be installed on the exposed face of the gabion prior to rock placement, two rows at 1/3 points on 3' high gabions, one row at 1/2 point in 1.5' high gabions.
- c. When filling 3-foot high gabions, rock shall be placed in 3 nominal 12-inch layers; when filling 1.5-foot high gabions, rock shall be placed in two 9-inch layers.
- d. Rock shall be placed in close contact in the unit so that maximum fill is obtained. The units may be filled by machine with sufficient hand work to accomplish requirements of this specification.
- e. Flat faces of rock shall be placed against the face of the wire mesh. Larger rocks should be utilized on the outside faces of the basket and smaller rocks placed on the interior of the baskets to fill voids.
- f. The last lift of rock in each cell shall be level with the top of the welded wire mesh basket in order to properly close the lid and provide an even surface for the top of the basket to close and be level.

B. Closure of Lids:

1. Lids shall be tied along the front, ends, and diaphragms of individual gabions and to successive gabions with 9-gauge spiral binders in the same manner as specified by the manufacturer. The use of crowbars or other single point leverage bars for lid closing is prohibited due to the potential for damage to the baskets.

3.04 SITE QUALITY CONTROL

A. Site Inspections:

1. Inspections:

a. Gabion Wall Installation:

- 1) Evaluate gabion walls for layout, placement of manufacturer stiffeners to keep baskets straight and true.
- 2) Rock placement to avoid damage to gabion walls and to ensure that rock color, texture and size are in compliance with the plans and as selected and approved by PSHIA Program/Project Manager.

B. Gabion Wall Acceptance:

1. Completed gabion wall work which meets the specified requirements will be accepted without qualification.
2. Completed gabion wall work which fails to meet one or more requirements but which has been repaired to be in compliance will be accepted without qualification.

C. Non-Conforming Work



1. Completed gabion wall work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in this Section.
 - a. The Phoenix Sky Harbor International Airport and the Program/Project Manager reserve the right to reject any or all items which do not meet the requirements of the Contract Drawings and Specifications.
 - b. Remove items determined to be non-conforming, and replace the non-conforming items removed with Work that conforms to the specified requirements.
2. Gabion Wall Appearance:
 - a. Repair defects which adversely affect the appearance of the gabion walls exposed to view if possible.
 - 1) If in the opinion of the Program/Project Manager the defect cannot be repaired, the gabion wall may be accepted or rejected as provided in this Section.
 - 2) Gabion Walls not exposed to view is not subject to rejection for defective appearance.

3.05 CLEANING

- A. At the end of each day, clean and remove waste gabion materials or rock material from the work area.

3.06 MEASUREMENT

- A. Welded wire mesh gabion basket retaining walls will be measured by the cubic yard by computing the volume of the rock filled baskets used.

3.07 PAYMENT

- A. The accepted quantities of Gabion basket retaining walls/welded wire mesh basket retaining walls, measured as provided above, will be paid for at the contract unit price per cubic yard, which price shall be full compensation for the work, complete in place, including excavating, bedding material, subgrade preparation (95% compaction), structural backfill (95% compaction at 9" vertical lifts), furnishing and installing the rock, filter fabric, soil reinforcement mats (limits specified on plans), and welded wire mesh baskets, and metal hardware as required. The soil reinforcement mats material, installation, compaction and structural backfill shall be considered incidental to the cost of the Gabion basket retaining walls/welded wire mesh basket retaining walls.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition





SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for designing cast-in-place concrete mixes.
 - 2. Requirements for furnishing, placing, and curing reinforced and unreinforced Portland cement concrete for concrete structures as indicated in the Contract Documents.
 - 3. Requirements for the testing and acceptance of cast-in-place concrete structures.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 03100 - Concrete Forms and Accessories.
 - 5. Section 03200 - Concrete Reinforcement.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. F_F: Flatness F-number.
 - 3. F_L: Levelness F-number.
 - 4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Cementitious Material: A mixture of cement and fly ash.
 - 2. Construction Joint: A bulkheaded joint in concrete having concrete reinforcement through the vertical surface.



3. Contraction/Expansion Joint: A joint in concrete for controlling cracking resulting from stresses caused by thermal expansion or contraction of the concrete.
4. Control Joint: A joint occurring in concrete where a concrete pour stops, and that has no concrete reinforcement through the joint so the joint can move horizontally as it cures and shrinks.
5. Flatness F-Number (F_F): A dimensionless number that defines the relative smoothness of a floor slab.
6. Levelness F-Number (F_L): A dimensionless number that defines the relative conformity of a floor surface to a horizontal plane.

C. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M182-05 - Standard Specifications for Burlap Cloth Made From Jute or Kenaf.
 - b. AASHTO M235M/M 235-13 – Standard Specifications for Epoxy Resin Adhesives.
2. American Concrete Institute (ACI):
 - a. ACI 117/10 - Specification for Tolerances for Concrete Construction and Materials and Commentary.
 - b. ACI 211.1-91 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - c. ACI 301-16 - Specifications for Structural Concrete.
 - d. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
 - e. ACI 302.2R - Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
 - f. ACI 304R - Guide for Measuring; Mixing, Transporting and Placing Concrete.
 - g. ACI 304.2R - Placing Concrete by Pumping Methods.
 - h. ACI 305R-10 – Guide to Hot Weather Concreting.
 - i. ACI 306R - Cold Weather Concreting.
 - j. ACI 308R - Guide to Curing Concrete.
 - k. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
3. American Institute of Steel Construction, Inc. (AISC):
 - a. AISC 303-16 - Code of Standard Practice for Steel Buildings and Bridges.
4. Arizona Department of Transportation (ADOT):
 - a. ADOT 2008 Standard Specifications for Road and Bridge Construction.
 - 1) Section 610 - Painting.
 - 2) Section 1002 - Paint.
5. ASTM International (ASTM):
 - a. ASTM C31/C31M-17 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.



- b. ASTM C33/C33M-16e1 - Standard Specification for Concrete Aggregates.
- c. ASTM C39/C39M-17b - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- d. ASTM C42/C42M-16 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- e. ASTM C94/C94M-17a - Standard Specification for Ready-Mixed Concrete.
- f. ASTM C138/C138M-17a - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
- g. ASTM C143/C143M-15a - Standard Test Method for Slump of Hydraulic-Cement Concrete.
- h. ASTM C50/C150M-17 - Standard Specification for Portland Cement.
- i. ASTM C157/C157M-17 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
- j. ASTM C171-16 - Standard Specification for Sheet Materials for Curing Concrete.
- k. ASTM C72M-17 - Standard Practice for Sampling Freshly Mixed Concrete.
- l. ASTM C173/C173M-16 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- m. ASTM C192/C192M-16a - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- n. ASTM C231M-17a - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- o. ASTM C309-11 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- p. ASTM C330M-17a - Standard Specification for Lightweight Aggregates for Structural concrete.
- q. ASTM C494/C494M-17 - Standard Specification for Chemical Admixtures for Concrete.
- r. ASTM C618-17 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- s. ASTM C881/C881M-15 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- t. ASTM C882/C882M-13a - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
- u. ASTM C1116/C1116M-10a(2015) - Standard Specification for Fiber-Reinforced Concrete.
- v. ASTM C1315-11 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- w. ASTM C1602/C1602M-12 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.



- x. ASTM D638-14 - Standard Test Method for Tensile Properties of Plastics.
- y. ASTM D695-15 - Standard Test Method for Compressive Properties of Rigid Plastics.
- z. ASTM D751-06(2011) - Standard Test Methods for Coated Fabrics.
- aa. ASTM D882-12 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- bb. ASTM D1434-82(2015)e1 - Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting.
- cc. ASTM D1709-16ae1 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
- dd. ASTM D1751-04(2013)e1 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- ee. ASTM D1752-04a(2013) - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- ff. ASTM D2582-16 - Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.
- gg. ASTM E96/E96M-16 - Standard Test Methods for Water Vapor Transmission of Materials.
- hh. ASTM E154/E54M-08a(2013)e1 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
- ii. ASTM E1155-14 - Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
- jj. ASTM E1745-17 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. Maricopa County:
 - a. Air Quality Department (MCAQD):
 - 1) Guidance for Dust Control Permit for Application.
 - 2) Application for Dust Control Permit.
 - 3) Dust Control Logs.
 - 4) Burn Permit Application,
<http://www.maricopa.gov/aq/divisions/compliance/dust/docs/pdf/BURN-APP2.pdf>.
 - b. Maricopa County Air Pollution Control Regulations:
 - 1) Regulation II – Permits and Fees:
 - a) Rule 200 – Permit Requirements, Section 305 – Dust Control Permit,



- http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/200-0803.pdf.
 - b) Rule 280 – Fees,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/280-0803.pdf.
 - 2) Regulation III – Control of Air Contaminants:
 - a) Rule 300 – Visible Emissions,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/300-0803.pdf.
 - b) Rule 310 – Fugitive Dust from Dust-Generating Operations,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310-0803.pdf.
 - c) Rule 310.01 - Fugitive Dust from Non-Traditional Sources of Fugitive Dust,
http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/310.01-0803.pdf.
 - 8. National Ready Mixed Concrete Association (NRMCA):
 - a. NRMCA Plant Certification Checklist – Section 3.
 - 9. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 51 Requirements for Preparation, Adoption, and Submittal of Implementation Plans.
 - b. U.S. Army Corps of Engineers (COE):
 - 1) COE Handbook for Concrete and Cement (Standards).
 - a) COE CRD-C 572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
 - 10. Institute for Sustainable Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Before concrete is to be placed, give a 10-day advance notice to those performing other construction work related to the concrete pours, such as to those performing work that must be supported by or embedded in concrete, to allow such items to be introduced or furnished before the concrete is placed.
2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

B. Pre-Installation Meetings:



1. Prior to placement of concrete, convene an onsite meeting to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of concrete elements.

RFI 1805 WTS GW Deck Placement Sequencing Time

C. Sequencing:

1. When placing concrete in walls and slabs, allow at least 2 days elapsed time for slabs and 5 days elapsed time for walls before concrete is placed against adjacent vertical joints.

D. Scheduling:

1. A minimum of 10 days prior to placing concrete, submit a schedule showing proposed construction methods, construction joint locations, and the sequence of pouring to the Program/Project Manager for approval.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Cement.
- 2) Fly ash.
- 3) Normal weight concrete aggregates.
- 4) Light weight concrete aggregates.
- 5) Water-reducing admixture.
- 6) Water-reducing and retarding admixtures, if required.
- 7) Water-reducing and accelerating admixtures, if required.
- 8) High-range, water-reducing admixture, if required.
- 9) Shrinkage-reducing admixture, if required.
- 10) Synthetic fibers.
- 11) Curing materials.
- 12) Clear curing and sealing compound.
- 13) Non-slip (dry-shake) aggregate surface.
- 14) Preformed expansion joint fillers.
- 15) Vinyl waterstops.
- 16) Surface applied waterstop.
- 17) Epoxy bonding compound.
- 18) Epoxy adhesive (for grouting dowels).
- 19) Construction joint devices.
- 20) Contraction joint inserts.
- 21) Construction and contraction joint filler (for slabs-on-grade).
- 22) Vapor barrier.



- 23) Acrylic emulsion paint.
 - b. Shop Drawings:
 - 1) Schedule showing proposed construction methods, construction joint locations, and the sequence of pouring.
 - c. Samples:
 - 1) Samples of materials being used when requested.
 - 2) Samples of each type of blast finish.
 - d. Certificates:
 - 1) Batch Mixing Plant Certification.
 - 2) Curing Compound/Architectural Finish Bond Certification.
 - 3) Clear Curing and Sealing Compound Certification.
 - 4) Fly Ash Certification.
 - 5) Mix/Admixture Certification.
 - e. Delegated Design Submittals:
 - 1) Proposed materials and methods to repair concrete surfaces.
 - 2) Design mixes on FINAL CONCRETE MIX DESIGN SUBMITTAL FORM.
 - 3) Materials and methods to be used to produce each type of blast finish.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Floor flatness/levelness test results.
 - 2) Shrinkage-Reducing Admixture Test results
 - b. Manufacturer's Instructions:
 - 1) Concrete material and accessories installation instructions.
 - c. Manufacturer's Reports:
 - 1) Copies of concrete delivery tickets.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - ENVISION Credit RA1.3 – Use Recycled Materials
 - 1) .
 - b. ENVISION Credit RA1.4 - User Regional Material
- 1.05 AT LEAST 60% OF ALL MATERIALS, PLANTS, AND SOILS ARE SOURCED WITHIN THE DISTANCES SPECIFIED: SOILS (50 MI, 80 KM), AGGREGATE (50 MI, 80 KM), CONCRETE (100 MI, 160 KM), PLANTS (250 MI, 400 KM), AND ALL OTHER MATERIALS (500 MI, 800 KM). QUALITY ASSURANCE
- A. Regulatory Agency Sustainability Approvals:
- 1. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
 3. U.S. Environmental Protection Agency Requirements:
 - a. Only provide curing compounds which comply with the low volatile organic compound (VOC) requirements as defined in 40 CFR 51.100, Requirements for Preparation, Adoption, and Submittal of Implementation Plans.
 4. Dust Control Permit:
 - a. If sandblasting operations will be performed for this Contract, comply with the requirements of the Maricopa County Dust Control Permit and air pollution control requirements, particularly Maricopa County Air Pollution Control Regulation Rules 310 and 310.01.
 - 1) Rule 310 requires maintaining daily logs recording the actual implementation of control measures identified in the Dust Control Permit.
 - b. Conspicuously post a copy of the Maricopa County Air Quality Department Dust Control Permits in a weather resistant location at the Site where it can be read by the workers.
- B. Certifications:
1. Batch Mixing Plant Certification:
 - a. Submit to the Program/Project Manager and local authorities requiring them, certificates originated by the batch mixing plant certifying the ready mixed concrete, as manufactured and delivered, is in conformance with ASTM C94/C94M.
 2. Curing Compound/Architectural Finish Bond Certification:
 - a. Submit written certification by the product manufacturer the liquid membrane-forming curing compound to be applied over concrete which is to receive an architectural finish is non-detrimental to the bond of the finish material.
 3. Clear Curing and Sealing Compound Certification:



- a. Submit written certification by the product manufacturer the curing and sealing compound is compatible with other treatments and finishes to be applied to the concrete.
 - 4. Fly Ash Certification:
 - a. Submit written certification by the product Supplier the fly ash conforms to the requirements specified.
 - 5. Mix/Admixture Certification:
 - a. Prior to submitting the concrete mix design to the Program/Project Manager for approval, submit written certification the mix conforms to the requirements of proposed admixtures.
- C. Site Samples:
 - 1. Submit Samples of materials being used when requested by the Program/Project Manager, including the Samples' names, sources, and descriptions.
 - 2. Submit Samples of each type of sandblast finish required not less than 12 inches by 12 inches in size, and indicate the materials and methods to be used to produce the finish.
- D. Mock-Ups:
 - 1. Mock-ups are required for structural concrete that requires a finish treatment.
 - a. Do not incorporate mock-ups into the final work.
 - b. Provide a mock-up showing the finish texture and color for exposed concrete surfaces not less than 3 feet by 3 feet in size.
 - 1) Furnish the number of mock-up panels necessary to obtain the approval of the color and texture on each panel.
 - 2) Approved mock-ups will serve as the standard for the aesthetic quality of the surface finish, and be called the Control Sample.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Delivery Tickets:
 - a. Each load of concrete from the batch plant must be accompanied by a delivery ticket.
 - b. Each delivery ticket must be signed by the Contractor's representative, and be annotated with the time and place of concrete pours from the load represented by the delivery ticket.
 - c. Keep the original delivery tickets as a record at the Site, and submit copies to the Program/Project Manager for information.
 - 1) Make delivery tickets available for inspection upon request by the Program/Project Manager.
 - d. Include the tabulation described by ASTM C94/C94M as well as any additional information the local codes may require on the delivery ticket.



B. Storage and Handling Requirements:

1. Store concrete admixtures so contamination, evaporation, moisture penetration, and damage are prevented.
2. Do not use concrete admixtures stored longer than 6 months.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Cold Weather Concreting:

- a. Perform cold weather concrete work in accordance with the requirements of ACI 306R and the following additional requirements:

- 1) The temperatures of the subbase and other surfaces in contact with concrete must be above freezing.
 - a) The subbase and surfaces of concrete forms must be free of snow and ice.
 - b) Do not place concrete around any embedment which has a temperature below freezing.
- 2) Provide heating equipment for protecting concrete and concrete materials during freezing or near-freezing weather.

- a) Do not use foreign materials or materials containing snow or ice.
 - b) When using artificial heat indoors, vent exhaust gases to the outside.

2. Hot Weather Concreting:

- a. Perform hot weather concrete work in accordance with the requirements of ACI 305R and the following additional requirements:

- 1) Do not deliver concrete having a temperature exceeding 90 degrees Fahrenheit to the Work Site.
- 2) Cool the mix's ingredients before mixing to prevent the temperature of the mix from exceeding 90 degrees Fahrenheit.
- 3) Furnish windbreaks, shading, fog spraying, sprinkling, or wet covering when necessary.

3. Contact with Aluminum Materials:

- a. Do not allow concrete to be in contact with aluminum materials at any time.

PART 2 PRODUCTS

2.01 SUSTAINABILITY REQUIREMENTS:

A. Sustainability Requirements:

1. Recycled Content

- a. For each mix design, provide 20% of fly ash by weight and the total material value for each mix type used on the project.

2. Regional Content



- a. For each mix design, provide component breakdown of concrete ingredients highlighting the extraction location and the distance to the Project site for each component.
- b. At least 60% of all materials are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), and all other materials (500 mi, 800 km).

2.02 DESIGN CRITERIA:

- A. American Concrete Institute (ACI) Compliance:
 1. Provide cast-in-place concrete work conforming to the requirements of ACI 301 except as modified by the Contract Documents.
- B. Concrete Design Mix:
 1. Water-Cement Ratio:
 - a. Use the cementitious material to determine the water/cementitious (W/C) ratio for the concrete in accordance with ACI 318/318R.
 - 1) Class AAA Concrete: Provide a maximum water-cement ratio of 0.45.
 - 2) Class AA Concrete: Provide a maximum water-cement ratio of 0.45.
 - 3) Class A Concrete: Provide a maximum water-cement ratio of 0.50.
 - 4) Class B Concrete: Provide a maximum water-cement ratio of 0.55.
 - 5) Class C Concrete: Proportion the mix to meet the strength requirements.
 2. Cementitious Material Content, Minimum:
 - a. Class AAA: 640 pounds per cubic yard.
 - b. Class AA: 600 pounds per cubic yard.
 - c. Class A: 520 pounds per cubic yard.
 - d. Class B: 470 pounds per cubic yard.
 - e. Class C: 420 pounds per cubic yard.
 3. Concrete Admixtures:
 - a. Only provide non-corrosive, non-chloride concrete admixtures.
- C. Delegated Design Submittals:
 1. Submit the manufacturer's descriptive Product Data and current specifications for the concrete materials and accessories specified in this Section to the Program/Project Manager for approval.
 2. Submit the manufacturer's installation instructions for the concrete materials and accessories specified in this Section to the Program/Project Manager for information.

2.03 PERFORMANCE:

- A. Concrete Mix Design Capacities:
 1. Compressive Strength, Minimum:



- a. Class AAA: 5000 psi or greater at 28 days as indicated on the Contract Drawings.
- b. Class AA: 4000 psi at 28 days.
- c. Class A: 3000 psi at 28 days.
- d. Class B: 2500 psi at 28 days.
- e. Class C: 2000 psi at 28 days.

2.04 MATERIALS

A. Cement:

- 1. Provide Portland cement conforming to the requirements for Type II, low alkali, cement specified in ASTM C150.
- 2. For exposed concrete, provide only one approved brand and manufacturer of cement.

B. Fly Ash:

- 1. Provide fly ash conforming to the requirements specified for Type F in ASTM C618.
- 2. Maximum Loss of Ignition: Not to exceed 4 percent.
- 3. Provide the same type and source of fly ash to manufacture concrete.

C. Normal Weight Concrete Aggregate:

- 1. Provide processed coarse and fine aggregate meeting the requirements of ASTM C33.
- 2. Coarse Aggregate:
 - a. Provide coarse aggregate complying with the following maximum size limitations, but in no case larger than 1 1/2 inches:
 - 1) One-fifth or less of the narrowest dimension between the sides of the forms within which the concrete is to be cast.
 - 2) Three-fourths or less of the minimum clear spacing between reinforcing bars.
 - 3) One-third or less of the slab thickness for unreinforced slabs.
 - b. Provide reduced aggregate with a particle size not less than 1/8 inch or more than 1/2 inch in any dimension, and containing a maximum of 5 percent of particles passing a No. 8 sieve.

D. Light Weight Concrete Aggregate:

- 1. Provide processed coarse and fine aggregate meeting the requirements of ASTM C 330.
- 2. Provide aggregate having a maximum size of 3/4 inch.
- 3. Provide reduced aggregate having a particle size not less than 1/8 inch.



E. Synthetic Fibers:

1. Provide 100 percent virgin polypropylene fibers complying with the requirements for reinforcing Type III concrete specified in ASTM C1116/C1116M, and having the following additional characteristics:
 - a. Length: 1-1/2 inch.
 - b. Color: Clear.
 - c. Tensile Strength: 90 ksi to 110 ksi.
 - d. Acid/Alkali Resistance: Excellent quality.
 - e. Absorption Rate: Nil.

F. Water:

1. Provide water clean and free of injurious amounts of oils, acids, alkalis, salts, organic materials, and other substances deleterious to concrete or concrete reinforcement.

G. Concrete Admixtures:

1. Admixture Manufacturers:
 - a. Provide admixtures produced by established, reputable manufacturers.
2. Water-Reducing Admixture:
 - a. Except for concrete including another admixture listed in this Paragraph 2.04.G, provide a water-reducing admixture conforming to the requirements for a Type A admixture specified in ASTM C494/C494M.
 - b. Manufacturers:
 - 1) The Euclid Chemical Company, Eucon WR-75, www.euclidchemical.com.
 - 2) BASF Admixtures, Inc., Pozzoloth 220N, www.basf-admixtures.com.
 - 3) Sika Corporation, Plastocrete 161, www.sikaconstruction.com.
 - 4) Approved equal.
3. Water-Reducing and Retarding Admixture:
 - a. Provide a water-reducing and retarding admixture conforming to the requirements specified for Type D in ASTM C494/C494M.
 - b. Manufacturers:
 - 1) The Euclid Chemical Company, Eucon Retarder-75, www.euclidchemical.com.
 - 2) BASF Admixtures, Inc., Pozzoloth 100XR, www.basf-admixtures.com.
 - 3) Sika Corporation, Plastiment, www.sikaconstruction.com.
 - 4) Approved equal.
4. Water-Reducing and Acceleration Admixture:
 - a. Provide a water-reducing and acceleration admixture conforming to the requirements specified for Types C or E in ASTM C494/C494M.
 - b. Manufacturers:



- 1) The Euclid Chemical Company, Accelguard 80, www.euclidchemical.com.
 - 2) BASF Admixtures, Inc., Pozzutec 20, www.basf-admixtures.com.
 - 3) Sika Corporation, Plastocrete 161 FL, www.sikaconstruction.com.
 - 4) Approved equal.
5. High-Range, Water-Reducing Admixture:
- a. Provide a high-range, water-reducing admixture conforming to the requirements specified for Type F in ASTM C 494/C 494M.
 - b. Manufacturers:
 - 1) The Euclid Chemical Company, Eucon 1037, www.euclidchemical.com.
 - 2) BASF Admixtures, Inc., Pozzolith 400N, www.basf-admixtures.com.
 - 3) Sika Corporation, Sikament 2000, www.sikaconstruction.com.
 - 4) Approved equal.
6. Shrinkage-Reducing Admixture:
- a. Provide a shrinkage-reducing admixture which reduces concrete shrinkage due to drying without reducing the concrete 28-day strength.
 - b. If air-entraining agents are used, provide a shrinkage-reducing admixture compatible with conventional air-entraining agents.
 - c. Shrinkage Reduction:
 - 1) Provide a shrinkage-reducing admixture which reduces the concrete shrinkage of concrete containing the admixture relative to concrete not containing the admixture between 41 percent and 62 percent when tested in accordance with the test method specified in ASTM C157/C157M.
 - d. Manufacturers:
 - 1) W. R. Grace and Company, www.na.graceconstruction.com.
 - 2) Approved equal.

2.05 MIXES

- A. Proportions of Ingredients:
1. Select the proportion of normal weight concrete in the mix in accordance with the requirements of ACI 211.1.
 2. Establish proportions of ingredients of the mix, including the water-cement ratio, on the basis of either laboratory trial mixture tests or standard deviation analysis, using the materials specified within this Section.
 - a. Perform the Laboratory Trial Mixture Test in accordance with Section 4 in ACI 301.
 - b. Perform the Standard Deviation Analysis in accordance with Section 4 in ACI 301.
 - c. Do not allow the fly ash content of the combined weight of fly ash and cement to exceed 25 percent.



- 1) Refer to the Contract Drawings for additional restrictions and limits to the use of fly ash.
3. Do not use fly ash in integrally colored concrete.

B. Slump:

1. Proportion and produce concrete to produce a slump as indicated in Table 03300-1.

Table 03300-1 Concrete Slump Requirements		
Type of Construction	Slump (Inches)	
	Maximum⁽¹⁾	Minimum
Reinforced foundation walls and footings	3	2
Slabs, stair pans and landings	4	3
Building columns, piers, and beams	4	3
Pavements and slabs-on-grade	3	1

2. For concrete containing high-range water-reducing admixtures, the maximum allowable slump after the admixture is added to concrete with an initial slump of 2 to 4 inches is 8 inches.

C. Admixtures:

1. Comply with the manufacturer's recommendations when using concrete admixtures.
2. Water-Reducing Admixture:
 - a. Unless high temperatures occur or placing conditions dictate a change, provide concrete containing a water-reducing admixture.
3. Water-Reducing and Retarding Admixture:
 - a. When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D).
 - 1) Notify the Program/Project Manager of this change, and submit product data for the water-reducing and retarding admixture prior to placing the modified concrete.
4. Water-Reducing and Accelerating Admixture:
 - a. When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture (Type C or E).
 - 1) Notify the Program/Project Manager of this change, and submit product data for the water-reducing and accelerating admixture prior to placing the modified concrete.



2.06 ACCESSORIES

A. Curing Materials:

1. Provide curing materials that will not stain or affect the concrete finish, or lessen the concrete strength.
 - a. Burlap:
 - 1) Provide burlap materials conforming to the requirements of AASHTO M182.
 - b. Sheet Materials:
 - 1) Provide sheet materials conforming to the requirements of ASTM C171.
 - c. Liquid Membrane Curing Compound:
 - 1) Provide liquid membrane curing compound material conforming to the requirements for Type 1 specified in ASTM C309.
 - 2) Provide liquid membrane curing compounds which are nontoxic, and have a maximum volatile organic compound (VOC) rating of 350 grams per liter in compliance with the requirements of the U.S. Environmental Agency.
 - 3) Ensure that liquid membrane curing compound is compatible with future concrete coatings and surface treatments.
 - 4) Manufacturers:
 - a) L&M Construction Chemicals, Inc., L&M Cure, www.lmcc.com.
 - b) BASF Admixtures, Inc., Masterkure 200W, www.basf-admixtures.com.
 - c) Euclid Chemical Company, Kurez DR, www.euclidchemical.com.
 - d) Approved equal.

B. Clear Curing and Sealing Compound:

1. Provide a liquid clear curing and sealing compound conforming to the requirements for Type I, Class A, specified in ASTM C1315.
2. Provide liquid clear curing and sealing compounds which are nontoxic, and have a maximum volatile organic compound (VOC) rating of 350 grams per liter in compliance with the requirements of the U.S. Environmental Agency.
3. Manufacturers:
 - a. Euclid Chemical Co., Super Diamond Clear VOX, www.euclidchemical.com.
 - b. BASF Admixtures, Inc., Sonneborn®, Kure-N-Seal 25LV, www.chemrex.com.
 - c. L&M Construction Chemical, Inc., Lumiseal WB Plus, www.lmcc.com.
 - d. Approved equal.



- C. Non-Slip (Dry-Shake) Aggregate Surfacers:
 - 1. Provide aluminum-oxide, non-slip aggregate surfacer to be applied to fresh concrete by the dry-shake method.
 - 2. Manufacturers:
 - a. Sonneborn; Frictex, www.chemrex.com.
 - b. Approved equal.
- D. Preformed Expansion Joint Fillers:
 - 1. Nonextruding and Resilient Bituminous Types:
 - a. Provide nonextruding and resilient bituminous types of joint fillers for exterior use in pavements and sidewalks only.
 - b. Provide nonextruding and resilient bituminous joint fillers conforming to the requirements of ASTM D1751.
 - 2. Sponge Rubber and Cork Type:
 - a. Provide sponge rubber and cork joint fillers conforming to the requirements of ASTM D1752.
 - 3. Self-Expanding Cork Type:
 - a. Provide self-expanding cork joint fillers conforming to the requirements of ASTM D1752.
 - 4. Manufacturers:
 - a. The Euclid Chemical Company/Tamms Industries, Inc., www.euclidchemical.com.
 - b. W. R. Meadows, Inc., www.wrmeadows.com.
 - c. APS Supply Company, <http://apscork.com>.
 - d. Approved equal.
- E. Vinyl Waterstops:
 - 1. Provide ribbed type waterstops conforming to the requirements of COE CRD C572, and manufactured from virgin polyvinyl chloride plastic compound.
 - 2. Construction Joints:
 - a. Provide flat ribbed 6-inch by 3/8-inch construction joints, such as Vinylex Corporation Catalog Number R6-38 with hog-rings.
 - 3. Expansion Joints:
 - a. Provide ribbed 9-inch by 3/8-inch expansion joints with a 1-1/2-inch outside diameter center bulb, such as Vinylex Corporation Catalog Number RLB9-38 with hog-rings.
 - 4. Manufacturers:
 - a. Vinylex Corporation, catalog numbers as specified above, www.vinylex.com.
 - b. The Euclid Chemical Company/Tamms Industries, Inc., www.euclidchemical.com.
 - c. W. R. Meadows, Inc., www.wrmeadows.com.
 - d. Greenstreak, www.greenstreak.com.
 - e. Approved equal.



F. Surface Applied Waterstop:

1. Provide a specially formulated joint sealant manufactured from chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties, and that swells upon contact with water.
 - a. Coat the waterstop with a coating formulated to inhibit initial expansion due to moisture present in fresh concrete.
2. Size: 10mm by 20mm dual extrusion design.
3. Provide the waterstop manufacturer's standard adhesive binder for securing the waterstop to hardened concrete.
 - a. Package surface applied waterstop in continuous length coils.
4. Manufacturers:
 - a. Greenstreak; Hydrotite CJ, www.greenstreak.com.
 - b. ADEKA; Ultraseal, www.adeka.com.
 - c. Vinylex, Swellseal 2010, www.vinylex.com.
 - d. Approved equal.

G. Epoxy Bonding Compound:

1. Provide a high-modulus, low-viscosity, moisture-insensitive epoxy adhesive conforming when mixed to the requirements for Type II, Grade 2, Classes B and C as specified in ASTM C881/C 881M; and having the following properties:
 - a. Compressive Strength (Minimum): 8,000 psi at 28 days when measured in accordance with the requirements of ASTM D695.
 - b. Tensile Properties:
 - 1) Tensile Strength (Minimum): 4,000 psi at 14 days when measured in accordance with the requirements of ASTM D638.
 - 2) Elongation at Break: One to three percent when measured in accordance with the requirements of ASTM D638.
 - 3) Modulus of Elasticity: 3×10^5 psi when measured in accordance with the requirements of ASTM D638.
 - c. Minimum Bond Strength (Plastic Concrete to Hardened Concrete): 1,700 psi at 14 days (moist cure) when measured in accordance with the requirements of ASTM C882.
2. Manufacturers:
 - a. Sika Corporation; Sikadur 32 Hi-Mod, www.sikaconstruction.com.
 - b. Euclid Chemical Company; Euco Epoxy #452 MV or #620, www.euclidchemical.com.
 - c. Fosroc, Inc.; Notobond 881, www.studiolina.com/studio/websites/fosroc.
 - d. Approved equal.

H. Epoxy Adhesive (For Grouting Dowels):

1. Provide a moisture insensitive epoxy adhesive of thick (gel) consistency conforming to the requirements for Type IV, Grades 2 and 3, Classes A, B, and C, except for gel times, as specified in ASTM C881/C881M, complying



with the requirements for Type IV Grade 3, Class A, B, and C except for gel times as specified in AASHTO M235, Type IV Grade 3, Class A, B, and C except for gel times, and having the following properties:

- a. Compressive Strength (Minimum): 10,000 psi at 28 days when measured in accordance with the requirements of ASTM D695.
 - b. Tensile Properties:
 - 1) Tensile Strength (Minimum): 3,000 psi at 14 days when measured in accordance with the requirements of ASTM D638.
 - c. Minimum Bond Strength (Hardened Concrete to Hardened Concrete): 2,000 psi at 14 days (moist cure) when measured in accordance with the requirements of ASTM C882.
2. Manufacturers:
- a. HILTI Hit-RE 500-SD; www.us.hilti.com.
 - b. Simpson Set XP, www.simpsonanchors.com.
 - c. Or approved equal.
- I. Construction Joint Devices:
1. Provide integral, galvanized steel construction joint devices formed to make a tongue and groove profile in slabs on grade.
 - a. For concrete areas exposed to view, provide plastic joint cap strips that can be removed to allow placement of sealant.
 2. Manufacturers:
 - a. Meadowburke, www.meadowburke.com.
 - b. Heckmann Building Products, Inc., www.heckmannbuildingprods.com.
 - c. Approved equal.
- J. Contraction Joint Inserts:
1. Provide two-piece, plastic, preassembled, preformed contraction joints with a depth of embedment equal to 1/4 of the slab thickness.
 2. Manufacturers:
 - a. Meadowburke, Burke Zip Strip, www.meadowburke.com.
 - b. W.R. Meadows, Speed - E - Joint, www.wrmeadows.com.
 - c. Approved equal.
- K. Construction and Contraction Joint Filler (For Slabs-on-Grade):
1. Provide two-component epoxy construction and control joint fillers.
 2. Manufacturers:
 - a. Sika Corporation, Sikadur 51 SL, www.sikaconstruction.com.
 - b. Euclid Chemical Company, Euro 700, www.euclidchemical.com.
 - c. BASF Admixtures, Inc., Masterfill 300, www.basf-admixtures.com.
 - d. Approved equal.
- L. Vapor Barrier:
1. Provide black, 3-ply, high-density polyethylene vapor barrier reinforced with nylon cords, and having the following properties.



- a. 3-inch Tensile Strength: 64 pounds when measured in accordance with the requirements of ASTM D882.
 - b. 3-inch Elongation: 450 percent when measured in accordance with the requirements of ASTM D882.
 - c. Puncture-Propagation Tear (PPT) Resistance: 15 pounds when measured in accordance with the requirements of ASTM D2582.
 - d. Tongue Tear: 11 pounds when measured in accordance with the requirements of ASTM D751.
 - e. Cold Creek: -25 degrees Fahrenheit when measured in accordance with the requirements of ASTM D1709.
 - f. Drop Dart: 1.75 pounds when measured in accordance with the requirements of ASTM D1709.
2. Manufacturers:
- a. STEGO Industries, LLC, Stego Wrap Vapor Barrier; www.stegoindustries.com.
 - b. Reef Industries, Inc.; Griffolyn Type 65 Barrier, www.reefindustries.com.
 - c. Raven Industries, Dura Skrim 8BBR, www.ravenind.com.
 - d. Inteplast Group; Barrier Bac VB 250 or VB 350, www.inteplast.com.
 - e. Approved equal.
- M. Advanced Vapor Barrier:
- 1. Provide multi-layer co-extruded vapor barrier complying with the requirements for Class C membrane specified in ASTM E1745, and manufactured from polyethylene and barrier resins having high impact strength and resistance to gas and moisture transmission, including methane and radon gas.
 - a. Thickness:
 - 1) Provide advanced vapor barrier that is a minimum of 20 mils (0.51mm) thick.
 - b. Tensile Strength:
 - 1) Provide advanced vapor barrier having a minimum tensile strength of 58 pounds (258N) when measured in accordance with Method B specified in ASTM E154.
 - c. Puncture Resistance:
 - 1) Provide advanced vapor barrier having a minimum puncture resistance of 2600 grams when measured in accordance with the method specified in ASTM D1709.
 - d. Temperature Limit:
 - 1) Provide advanced vapor barrier capable of functioning up to a temperature of 180 degrees Fahrenheit (82 degrees Celsius).
 - e. Permeance:
 - 1) Provide advanced vapor barrier having a permeance of 0.090 U. S. Perms (0.060 Metric Perms) when measured in accordance with the method specified in ASTM E154.



- 2) Alternately, provide advanced vapor barrier having a water vapor permeance of 0.030 U. S. perms when measured in accordance with Method B1 specified in ASTM E 96/E96M.
- f. Radon Diffusion Coefficient:
 - 1) Provide advanced vapor barrier having a radon diffusion coefficient of less than 0.25×10^{-12} square meters per second when determined using the method developed by the Technical Research Institute of Sweden.
- g. Methane Permeability:
 - 1) Provide advanced vapor barrier having a methane permeability of less than 5×10^{-10} square meters per day-atmosphere when measured in accordance with the method specified in ASTM D1434.
2. Manufacturers:
 - a. Raven Industries, VaporBlock® Plus™ 20, www.ravenind.com.
 - b. W. R. Grace and Company, Florprufe® 120, <http://www.grace.com>.
 - c. Approved equal.
- N. Acrylic Emulsion Paint:
 1. Provide acrylic emulsion paint complying with the requirements of Sections 1002-2.04 and 1002-3 (D) in the ADOT Standard Specifications for Road and Bridge Construction.

2.07 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 - a. Prior to producing concrete, submit all mix designs proposed for the Contract to the Program/Project Manager for approval on the form appended to the end of this Section.
 - 1) Include a standard deviation analysis or laboratory trial mixture test data with the submittal in accordance with Section 4 of ACI 301.
 - 2) Use the materials specified in this Section in the proposed design mixes.
 - 3) Make adjustments in the proposed design mix as directed by the Program/Project Manager.
 2. Shrinkage-Reducing Admixture Test:
 - a. Test Procedure:
 - 1) Test normal weight fiber-reinforced concrete containing the shrinkage-reducing admixture for shrinkage in accordance with the test method specified in ASTM C157/C157M.
 - 2) Submit the concrete mix design for the normal weight fiber-reinforced concrete containing the shrinkage-reducing admixture



- and the Shrinkage-Reducing Admixture Test results to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Concrete having shrinkage within the percentages specified passes the Shrinkage-Reducing Admixture Test.
 - B. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when concrete for this Contract is being mixed, placed, and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Inspect the locations intended to receive cast-in-place concrete for deficiencies which would prevent proper execution of the concrete work.
 - 2. For each elevated slab support system, verify that the steel erector/fabricator team has surveyed the erected structural steel frame and defined the top of steel elevation of the floor members and the edge of slab locations, and review these structural steel frame surveys to understand the conditions prevailing.
 - a. Prior to placing concrete, determine potential levelness issues related to the floor slab tolerance requirements listed in Paragraph 3.03.H.
- B. Evaluation and Assessment:
 - 1. Do not proceed with concrete placement until deficiencies discovered by the inspection are corrected to the satisfaction of the Program/Project Manager.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Prepare formwork in advance in accordance with the requirements of Section 03100, Concrete Forms and Accessories.
 - a. Remove snow, ice, water, and debris from within the forms in advance of concrete pours.
 - 2. Pre-position reinforcement in accordance with the requirements of Section 03200, Concrete Reinforcement; in advance of concrete pours.
 - 3. Sprinkle the subgrade sufficiently to eliminate water loss from concrete in accordance with ACI 302.1R.



- a. Before placing concrete, verify the subgrade is moist with no free water and no muddy or soft spots.
4. Vapor Barrier:
 - a. Provide vapor barrier under floor slabs where shown on the Contact Drawings, when its use is stipulated in the soils report, or where the finish flooring manufacturer recommends its use; and coordinate with the finish flooring manufacturer to ensure the barrier product used for that application is appropriate.
 - b. Immediately before pouring concrete floor slabs, place the vapor barrier on crushed stone base under the slab pours.
 - 1) Lap all vapor barrier sides 6 inches and vapor barrier ends 12 inches.
 - 2) Patch holes and rips in the vapor barrier film to the satisfaction of the Program/Project Manager.
 - 3) At exterior walls, turn the vapor barrier up to the top of the slab.
 - c. Coordinate vapor barrier placement with the installation of the perimeter foundation insulation.
5. Pre-position waterstops, expansion joint materials, anchors, and other embedded items in advance of new concrete pours.
 - a. PVC Waterstops:
 - 1) Provide PVC waterstops with hog-rings in all joints where water tightness is required.
 - a) Provide PVC waterstops in joints exposed to liquids at bottom of walls for elevator and escalator pits, or where shown in the Contract Documents.
 - b) In substructures and other structures required to be watertight, install waterstop if concreting is to be discontinued for a sufficient length of time which could result in undesirable seepage cracks developing in the concrete.
 - c) On expansion joints, center the waterstop so one-half of the waterstop width is embedded in the concrete on each side of the joint.
 - (1) Keep the PVC waterstop's center bulb un-embedded.
 - 2) Use continuous lengths without splices where possible.
 - a) Connect all adjoining waterstops, including vertical and horizontal runs, to provide a continuous water barrier.
 - b) Provide factory-formed and tested waterstop corners and intersections leaving only straight butt joint splices in the field.
 - 3) Adequately support waterstops to prevent displacement and deformity of the waterstops during concrete pours.
 - 4) Maintain a 2-inch minimum clearance between the waterstop and reinforcing steel.
 - 5) Splices:
 - a) Heat seal adjacent surfaces in accordance with manufacturer's recommendations using a thermostatically



- controlled electric source of heat that provides sufficient heat to melt but not to char the material.
- b) Splice Strength: Not less than 50 percent of the mechanical strength of the parent section.
 - c) Water Tightness: Make the splices' water tightness equal to the continuous PVC waterstop material.
- b. Surface Applied Waterstops:
- 1) Provide surface applied waterstops at the locations indicated on the Contract Drawings.
 - 2) Install the surface applied waterstops in strict accordance with the manufacturer's installation instructions.
- c. Embedded Pipes and Conduits:
- 1) The Program/Project Manager may permit material not harmful to the concrete to be embedded in the concrete if the following conditions are satisfied:
 - a) The item(s) to be embedded do not cross expansion joints within the slab depth.
 - b) The maximum outside dimension of an item to be embedded is not greater than one-third the overall thickness of the member in which it is to be embedded.
 - c) The minimum spacing between items to be embedded is not less than 3 widths on center, or 3 inches clear between items, whichever is less.
 - d) The item(s) to be embedded will not impair the strength of the concrete member.
 - e) A 2-inch minimum clearance from the embedded item(s) to the face of the concrete slab is maintained.
 - f) The item(s) to be embedded are not made of aluminum.
 - g) The item(s) to be embedded are coated, taped, or wrapped in accordance with governing code requirements.
 - h) Concrete reinforcement within the concrete member will not be cut, bent, or displaced in order to embed the item(s) unless approved by the Program/Project Manager.
- d. Anchor Rods:
- 1) Install anchor rods accurately, both vertically and horizontally, in the formwork as shown on the Contract Drawings.
 - 2) Ensure anchor rods are held firmly in the correct position and at the proper elevation by suitable templates during the placement of concrete.
 - 3) Limit the variation in the locations of anchor rods and other embedded items from the dimensions shown on the Contract Drawings to within the tolerances listed in AISC 303.
6. Anchor Reinforcement Dowels into Existing Concrete.
- a. Using a carbide tip bit or star bit, drill holes for each dowel to the size and depth indicated on the Contract Drawings.



- 1) Core drilling is not permitted.
- 2) Do not drill into, cut, or otherwise damage existing reinforcement bars.
 - a) If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Program/Project Manager.
 - (1) Plug unused holes as directed by the Program/Project Manager.
 - b. Blow clean each finished hole with an oil free air jet, and then flush the hole with a jet of clean water.
 - c. Immediately prior to placing and grouting the dowel bar into the hole, remove all water from the hole and from the walls of the hole.
 - d. Mix and place epoxy adhesive completely around the dowel bar in the hole in strict accordance with the manufacturer's recommendations.
 - 1) Do not exceed the manufacturer's specified time limit within which the material must be placed after mixing.
 - 2) Do not re-temper grout that has begun to stiffen; discard such grout.

3.03 CONSTRUCTION

A. Construction of Concrete Elements:

1. Construct the concrete elements indicated on the Contract Drawings or in the Specifications; including but not limited to beams, columns, slabs, foundations, in-ground encasement of piping and conduit, reaction backings for piping, concrete backfill, and the reinforced concrete bases for equipment and piping provided under this Contract.
2. Provide only Class AA concrete to construct concrete elements for this Contract except where indicated otherwise on the Contract Drawings or in the Specifications.
 - a. For in-ground encasement of piping, provide Class B concrete.
 - 1) Encase pipes under structures and buildings or indicated to be encased in concrete on the Contract Drawings in concrete for the full length of the pipe run under the structure and as indicated.
 - b. For in-ground encasement of conduit runs, provide Class B concrete.
 - 1) Encase conduit runs indicated on the Contract Drawings.
 - c. For reaction backings, provide Class B concrete.
 - d. For backfilling of over-excavated foundation area, foundation voids, and cavities, provide Class C concrete.

B. Concrete Production:

1. Furnish plant equipment and facilities conforming to the requirements specified in the NRMCA Plant Certification Checklist - Section 3 for producing ready-mixed concrete.



2. Batch, mix, and transport ready-mixed concrete in accordance with ASTM C 94/C 94M.
3. Add admixtures to the mix in accordance with ACI 301.
4. For synthetic fiber-reinforced concrete, add the synthetic fibers at a rate of 1.5 pounds per cubic yard of concrete.
5. Do not add water to concrete mixes at the Work Site unless it has been withheld from the mix at the batch mixing plant.
 - a. Indicate the amounts of mix water to be withheld for later addition at the Work Site on the approval form.
 - b. If the Program/Project Manager approves adding water to the mix at the Site, perform additional revolutions at the mixing speed to adequately incorporate the additional water into the mixture.
6. Provide reduced aggregate concrete only for use in metal pan stairs.

C. Conveying and Placing Concrete:

1. Maintain the required concrete quality by rapidly conveying the concrete from the mixer to the location of the placement, and by using methods which will prevent segregation and loss of ingredients.
 - a. After introducing either the mixing water to the cement and aggregates, or the cement to the aggregates, complete discharging the concrete within 1-1/2 hours or before the mixing drum has revolved 300 revolutions; whichever comes first.
 - b. Do not convey concrete through aluminum or aluminum alloy equipment.
 - c. Do not place concrete if concrete temperature exceeds 90 degrees Fahrenheit.
2. If the concrete is to be conveyed and placed by pumping, conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
 - a. Do not place concrete by pumps or other similar devices without prior written approval of the Program/Project Manager.
3. Place concrete in accordance with the requirements of ACI 304R and the additional requirements specified in this Section.
 - a. Do not drop concrete freely more than 4 feet or in areas where reinforcing will cause segregation.
 - b. Deposit concrete in approximately horizontal layers 12 to 18 inches deep.
 - c. Do not allow concrete to flow laterally more than three feet.
 - d. Do not use concrete which has partially hardened, or has been contaminated by foreign materials.
 - 1) Place concrete at a rate so the concrete which is being integrated with the fresh concrete is still plastic.
 - 2) Do not deposit concrete on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
 - e. Do not place concrete in forms containing standing water.



- f. Do not bend reinforcement out of position when placing concrete.
- g. Within pour sections, continuously place concrete to produce a monolithic unit.
- h. Do not cast or erect beams, girders, or slabs supported by columns or walls until the concrete in the vertical support members is 7 days old.
- i. Do not place concrete on frozen surfaces.
- j. Sequence concrete pours in accordance with Paragraph 1.03.C.
- k. Comply with special requirements specified in Article 1.07 for placing concrete during cold or hot weather.

D. Consolidating Concrete:

- 1. Consolidate concrete by vibration only.
 - a. Work the concrete around the concrete reinforcement and embedded items, and into corners.
 - b. Eliminate all air or stone pockets; and eliminate other causes of honeycombing, pitting, and planes of weakness.
 - c. Use vibrators capable of transmitting vibrations to the concrete in frequencies sufficient to provide satisfactory consolidation.
 - 1) Use the internal type of vibration equipment, and not the type attached to forms or concrete reinforcement.
 - 2) Do not use vibrators to spread the concrete.
 - d. Do not leave vibrators in one spot long enough to cause segregation.
- 2. Keep sufficient vibration equipment in reserve on the Site to prevent a shutdown of the Work occasioned by a failure of the primary vibration equipment.

E. Joints:

- 1. Joint Locations:
 - a. Only the locations of critical joints are indicated on the Contract Drawings.
 - 1) Locate additional joints in walls, slabs, and foundations throughout the structures as required.
 - a) 10 days prior to scheduled concrete pours, submit requests for additional joint locations associated with the pours to the Program/Project Manager for approval.
 - b) Do not make concrete pours unless the joint locations have been approved by the Program/Project Manager.
 - b. Install expansion joints and contraction joints where indicated on the Contract Drawings.
 - c. Locate additional contraction joints and construction joints in slabs-on-grade at the following maximum spacing unless noted otherwise:
 - 1) In 5-inch slabs, space the joints 12 feet apart each way.
 - 2) In 6-inch slabs, space the joints 15 feet apart each way.
 - 3) In 8-inch slabs, space the joints 20 feet apart each way.
 - d. Locate the additional construction joints required in walls and foundations where they will least impair the strength of the structure.



- 1) Do not locate construction joints in continuous grade beams and footings more than 60 feet apart horizontally.
 - 2) Do not locate construction joints in foundation mat slabs more than 30 feet apart horizontally.
 - 3) Do not locate construction joints in continuous walls more than 30 feet apart horizontally.
 - a) At corners or other intersections of 2 or more walls, provide construction joints in each wall less than 20 feet from the intersection point in all directions.
 - b) Align construction joints in walls with the construction joints placed in the supporting foundation element (base slab, continuous footing, grade beam), or offset the construction joints a minimum of 5 feet.
2. Construction Joints:
- a. Provide keyways in construction joints where indicated on the Contract Drawings.
 - b. Provide PVC waterstops in construction joints exposed to liquids, are in contact with earth, or are exposed to the weather.
 - c. If concrete placement is interrupted long enough for a “cold joint” (hardened surface) to form, install keyway with embedded dowels so one splice length will extend into the present concrete section pour, and one splice length will extend into the adjacent future pour.
 - 1) Size the embedded dowels to match the size of the concrete reinforcement in the slab, wall, or foundation being poured.
 - 2) For installing dowels into hardened concrete or concrete that has reached its final set, comply with the requirements specified in Subparagraph 3.02.A.6.
 - 3) Do not “wet stab” dowels into fresh concrete or concrete that has not reached its final set.
 - d. Horizontal construction joints are not permitted in slabs or footings; and are not allowed in beams, unless the joints in the beams are detailed in the structural Contract Drawings.
3. Control Joints and Construction Joints in Slabs-On-Grade:
- a. Control joints in a slab-on-grade can be provided using a contraction joint insert.
 - 1) Press a straight edge cutting tool into the slab’s wet concrete to part the aggregate.
 - 2) Place the insert into the separation until the top of the insert lays on the surface of the wet concrete.
 - 3) Remove the top section of the insert, and float the concrete to fill voids adjacent to the insert and finish the concrete surface.
 - b. Contraction joints can be provided in a slab-on-grade by saw-cutting a continuous straight slot to a depth of one-fourth the thickness of the slab.



- 1) Submit detailed procedures and plans to the Program/Project Manager for review and acceptance before constructing control joints.
 - 2) Saw the slot as soon as the concrete has hardened sufficiently; but complete the sawing within 12 hours after the concrete has been placed.
 - 3) When saw cutting a new joint that crosses an existing saw cut joint, provide corner break-out protection for the existing joint.
 - c. Fill all construction and contraction joints in slabs-on-grade with the construction and contraction joint filler specified herein.
 4. Expansion Joints and Control Joints in Walls:
 - a. Do not extend reinforcing or other embedded metal items through expansion and control joints except where indicated otherwise on the Contract Drawings.
 - b. For expansion joints and control joints exposed to liquids, in contact with earth, or exposed to the weather; provide PVC waterstops in the joints.
 5. Bonding New Concrete to Hardened Concrete:
 - a. Bond fresh new concrete to hardened, previously poured concrete in accordance with one of the following:
 - 1) Roughen to ¼" amplitude and clean the hardened concrete to remove foreign matter and laitance, and then saturate the hardened concrete with water for 24 hours immediately prior to the pour and remove standing water.
 - 2) Apply bonding agent in accordance with the manufacturer's printed instructions. Coordinate selection of epoxy with the working time of epoxy and concrete placement and forming operation. Acceptable manufacturers and products include the following:
 - a) Sika Armatec 110 Epocem by Sika
 - b) Sikadur 32 Hi-Mod by Sika
 - c) Or Approved Equal
 6. No exceptions to the specified requirements for joints are permitted unless written approval is given by the Program/Project Manager.

F. Finishing Concrete:

 1. Formed Surface Finishes:
 - a. Apply one or more of the following finishes to the surfaces of formed concrete after removing the forms:
 - 1) Rough Form Finish:
 - a) The surface of the formed concrete may not include roughness and irregularities exceeding 1/2 inch.
 - b) Patch tie holes and defects.
 - 2) Ordinary Wall Finish:



- a) The surface of the formed concrete must be true and uniform without any conspicuous offsets or bulges.
 - b) Gradual irregularities may not exceed 1/2 inch, and abrupt irregularities may not exceed 1/4 inch.
- 3) Plywood Finish:
 - a) The surface must comply with the requirements for the Ordinary Wall Finish, except gradual irregularities exceeding 1/2 inch and abrupt irregularities exceeding 1/8 inch must be removed.
 - (1) Completely remove all fins on the surface.
 - (2) Rub the surfaces which cannot meet these requirements as specified in Subparagraph 3.03.F.1.a.4.
 - b) Construct the surface of the forms using 5/8-inch plywood or boards lined with tempered hardboard not less than 3/16 inch thick
 - c) Place the plywood or liner sheets in an orderly and symmetrical arrangement using sheets as large as practicable.
 - d) Do not use sheets showing torn grain, worn edges, patched holes from previous use, or other defects which will impair the texture of the concrete surfaces.
- 4) Rubbed Finish:
 - a) This finish is applied to a freshly hardened Plywood Finish.
 - b) Wet the surfaces, and rub them with a carborundum brick or other abrasive until all form marks, projections, and irregularities have been removed; and a smooth uniform surface, texture, and color are produced.
 - c) Complete the rubbing operation within one day of the removal of the concrete forms.
 - d) Wash the surface clean after rubbing with water.
- 2. Unformed Surface Finishes:
 - a. Apply one or more of the following finishes to the surfaces of unformed concrete:
 - 1) Floated Finish:
 - a) After the concrete has been placed, consolidated, struck off, and leveled, do no further work until the concrete is ready for the floating operation.
 - b) Begin a floating operation when the water sheen has disappeared and the surface of the concrete has stiffened sufficiently to permit the operation.
 - (1) During or after the first floating, check the planeness of the surface.
 - (2) Eliminate high spots and fill low spots in the slab pour.
 - (3) Re-float the slab to a uniform texture having a finish within the floor flatness/levelness tolerance specified in



Subparagraph 3.03.H.2, and complying with the criteria indicated on the Contract Drawings.

- 2) Steel Trowel Finish:
 - a) This finish is applied to a fresh Floated Finish by working the floated finish with a steel trowel.
 - (1) Perform the first troweling to produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
 - (2) Perform additional trowelings by hand after the surface has hardened sufficiently.
 - (3) Perform the final troweling when a ringing sound is produced as the trowel is moved over the surface.
 - b) Thoroughly consolidate the surface by hand trowel operations to produce a finished surface essentially free of trowel marks, uniform in texture and appearance.
- 3) Broom or Belt Finish:
 - a) This finish is applied immediately to a fresh Floated Finish by drawing a broom or burlap across the surface to give the surface a coarse transverse scored texture.
- 4) Nonslip Finish:
 - a) Apply non-slip aggregate surfacer to the surfaces using the "dry shake" method of application.
 - b) Apply the non-slip aggregate surfacer in accordance with manufacturer's recommendations and at a rate not less than 25 pounds per 100 square feet.
3. Special Finishes:
 - a. Deck Finish:
 - 1) After the first power or single hand troweling of the slab surface, draw a light hair broom across the slab to produce a fine shallow scored texture.
 - b. Architectural Finishes: 24th St Station Topping
Slab Mix Design RFI
1996
 - 1) Provide special finishes as specified or indicated on the Contract Drawings.
 - 2) Terrazzo Style Decorative Concrete Finish: Decorative concrete is produced by grinding and finishing trowel finished cured concrete in a manner similar to that for terrazzo.
 - a) Rough Grinding: Grind with 26 grit diamond plugs to remove surface fines and expose aggregate. Maintain specified concrete flatness.
 - b) Following initial grind with two additional grinds using 80 grit diamonds and 80 grit stones (max. depth of grind = 1/8")
 - c) Cleanse floor with clean water and rinse. Remove excess rinse water to prevent staining.



- d) Steel trowel Portland Cement grout onto surface to fill all voids, cement grout to match color of concrete, allow to cure overnight.
 - e) Fine Grinding: Grind with 80 grit (or finer) stones to remove grout and 120 grit diamonds until polished terrazzo-like surface is achieved. Concrete shall show a minimum of 60 percent aggregate.
 - f) Wash all surfaces with neutral cleaner with Ph factor between 7 and 10, biodegradable and phosphate free.
 - g) Rinse with clear water and allow to surface dry.
 - h) Seal surface with two coats of approved solvent based acrylic penetrating sealer.
- 3) Sandblast Finish:
- a) To ensure the surfaces to be blasted are at the same age in order that uniform finishes result, coordinate the construction and removal of formwork with blasting.
 - b) During abrasive blast finishing operations, protect adjacent areas and materials from dust, dirt, and physical damage.
 - c) Use abrasive grit of the proper type and grade to expose aggregate and the surrounding matrix surface to duplicate finish on the Control Sample mock-up.
 - d) Perform the blasting in as continuous an operation as possible, using the same crew and equipment to maintain the continuity of the finish.
 - e) Carefully blast edges and corners with abrasive so uniform edges and corners are maintained.
- 4) Painted Concrete Surfaces:
- a) Paint concrete surfaces of the elevated guideway structures where indicated on the Contract Drawings using acrylic emulsion paint in accordance with Section 610-3.05 (B) (4) of the ADOT Standard Specifications for Road and Bridge Construction to match the beige color prevalent in the airport as directed by the Program/Project Manager.
4. Whether the concrete is to remain natural concrete or will receive an additional applied finish or material, finish the concrete surfaces as indicated or scheduled on the Contract Drawings and as specified in this Section.
- a. For concrete having unformed surfaces, use just enough mortar to avoid the need for excessive floating.
 - b. Slope exposed unformed surfaces to provide quick, positive drainage; and to avoid puddles in low spots.
 - 1) Unless noted otherwise on the Contract Drawings, slope all unformed surfaces exposed to the weather 1/4 inch per foot for drainage.



5. Unless the type of finish is indicated on the Contract Drawings or is a Special Finish, finish concrete surfaces as follows.
 - a. Rough Form Finishes:
 - 1) Provide a Rough Form Finish on concrete surfaces to be covered by earth.
 - b. Ordinary Wall Finishes:
 - 1) Provide an Ordinary Wall Finish for the following:
 - a) Interior and exterior concrete wall surfaces not exposed to view.
 - b) The undersides of concrete slabs to be covered by architectural ceilings.
 - c. Plywood Finishes:
 - 1) Provide a Plywood Finish for all surfaces to be painted.
 - d. Rubbed Finishes:
 - 1) Provide a Rubbed Finish for the following:
 - a) Interior and exterior concrete surfaces exposed to view which will not be painted.
 - b) Exterior concrete surfaces above the level beginning 6 inches below finished ground.
 - c) Concrete equipment pads.
 - e. Floated Finishes:
 - 1) Provide a Floated Finish for all unformed concrete surfaces unless otherwise specified.
 - f. Steel Trowel Finishes:
 - 1) Provide a Steel Trowel Finish for the following:
 - a) Interior floors of structures except where an Architectural Finish is to be applied.
 - b) Interior concrete stair treads.
 - c) The tops of exposed concrete walls.
 - g. Broom or Belt Finishes:
 - 1) Provide a Broom or Belt Finish for the following:
 - a) Exterior concrete ramps.
 - h. Non-slip Finishes:
 - 1) Provide a Non-Slip Finish for exterior concrete stair treads and landings.
 - i. Architectural Finishes:
 - 1) Provide Architectural Finishes as specified or indicated on the Contract Drawings.

G. Curing Concrete:

1. Immediately after placing and finishing concrete, protect the concrete from premature drying, excessive hot or cold temperatures, wind, dust storms, and mechanical injury.
2. Cure the concrete by water curing, sheet form curing, or liquid membrane curing compound methods in accordance with ACI 308R.



- a. Cure concrete continuously for a minimum of 7 days at ambient temperatures above 40 degrees Fahrenheit.
 - 1) Cure the concrete during cold weather according to the requirements of ACI 306R.
 - 2) Cure the concrete during hot weather according to the requirements of ACI 305R.
- b. If liquid curing compounds will be used to cure the concrete, complete finishing operations prior to applying the compound; and apply the compound as soon as the free water on the concrete surface disappears and no water sheen is visible.
 - 1) Do not use liquid curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coatings, dampproofing, waterproofing, future grout, grout fill, or other coatings.
 - 2) Do not use liquid curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees Fahrenheit.
 - 3) The surface must be capable of having workers walk on it without marring the surface.
 - 4) Using a high-pressure airless sprayer, apply 2 uniform coats of liquid curing membrane compound following the manufacturer's application recommendations.
 - a) Apply the second coat perpendicular to the first coat.
 - b) Do not apply liquid curing membrane compound to the surfaces of construction joints.
 - c) Protect exposed reinforcement during application of liquid curing membrane compound.
 - d) Water cure those areas not coated with liquid curing membrane compound.
 - e) Where an area has been accidentally coated with curing membrane compound or another special coating, clean this excess coating from the surface by blast cleaning or using another method recommended by the manufacturer of the special coating.
3. Protect the finished surfaces and slabs from hot dry wind and the direct rays of the sun to prevent checking and crazing.

H. Tolerances:

1. Provide concrete surface and finish elevations in accordance with the requirements of ACI 117.
2. Floor Flatness/Levelness Tolerances:
 - a. Measure floor tolerances, both the flatness F-number (F_F) and the levelness F-number (F_L), in accordance with the requirements specified in ASTM E1155.



- 1) Perform floor tolerance tests within 24 hours after concrete placement occurs, and submit the test results to the Program/Project Manager within 72 hours of the testing.
- 2) Levelness F-numbers (F_L) do not apply to un-shored steel framed construction.
 - a) In this case, allowable variations from the top of slab elevations indicated on the Contract Drawings are plus or minus $3/8$ inch.
- b. Overall F Numbers:
 - 1) Overall F_F numbers and F_L numbers represent a test surface defined as the total floor area of 1 building level.
 - 2) Overall F numbers for the floor must conform to the floor classifications defined on the Contract Drawings and in ACI 117.
- c. Local F Numbers:
 - 1) Local F_F numbers and F_L numbers represent a test section within a concrete pour.
 - 2) Each test section may not exceed 2500 square feet in area.
 - 3) Local F number tolerances must at a minimum be $2/3$ of the specified overall F number tolerances.
3. The tolerance of the horizontal distance from the centerline of the guidebeam (PGL) to the edge of the concrete at a station platform is $+1/2''/-0''$.

3.04 REPAIR/RESTORATION

- A. Remove concrete that has been segregated into ingredients during consolidation by vibrator operations, and replace the segregated concrete removed with new concrete.
- B. Repair of Formed Concrete Surfaces:
 1. As soon as the forms have been stripped from the concrete and the concrete surfaces have been exposed, do the following:
 - a. Remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair the structural strength of the concrete.
 - b. Clean all exposed concrete surfaces and adjoining areas stained by the leakage of concrete to the satisfaction of the Program/Project Manager.
 2. Repair tie holes and other small cavities by cleaning out the resulting cavities, wetting the cavity area, and then filling the cavity with a stiff mortar of the same material used in the concrete, but somewhat leaner.
 3. Repair and patch other defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete.
 - a. Produce a finish on the patch indistinguishable from the surrounding concrete.



4. Where honeycomb or voids are not excessive, and repairs are authorized by the Program/Project Manager; saw cut a 1/2 to 3/4 inch deep square outline around the area of defective concrete, and chip out the defective concrete inside the outline to a depth not less than 2-inches until sound solid concrete is encountered.
 - a. If chipping is necessary, make the edges of the depression perpendicular to the concrete surface or slightly undercut to provide a key at the edge of the patch.
 - b. Thoroughly clean, dampen, and brush coat the area to be patched with neat cement grout; and follow this preparation by placing a cement mortar to patch the concrete.
 - 1) Other patching materials may be used if accepted by the Program/Project Manager in writing prior to start of repair work.
 - c. Keep the patch damp for 7 days at a temperature above 50 degrees Fahrenheit.

C. Repair of Unformed Concrete Surfaces:

1. Finished flatwork exceeding the allowable tolerances may be repaired provided the strength or appearance of the flatwork is not adversely affected.
 - a. Remove high spots with a terrazzo grinder.
 - b. Fill in low spots with an approved patching compound.
 - c. Perform other remedial measures as permitted by the Program/Project Manager.
2. Surface defects on unformed surfaces may be repaired provided the strength or appearance of the item is not adversely affected.
 - a. Remove high spots and surface irregularities with a diamond-disk or stone grinder.
 - b. Fill in low spots with an approved patching compound.

D. The Program/Project Manager will determine the extent and manner of actions to be taken to repair defective concrete.

1. Obtain approval from the Program/Project Manager before performing repair work other than removing imperfect texture and filling pin holes and insert holes.
2. Prior to repairing defects, submit proposed materials and repair methods to the Program/Project Manager for approval.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing



- personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
- b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders on the Work Site for the sole use of the Testing and Inspection Agency and the code-required Approved Agency.
 - c. Strength testing requirements are based on using 6 inch by 12 inch size cylinders.
 - d. Provide containers for transporting concrete test cylinders to the testing laboratory.
 - e. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - f. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Concrete Slump Test:
- a. Test Procedure:
 - 1) Determine the slump of a concrete sample from each truckload of concrete upon its arrival at the Work Site, and from other concrete whenever the consistency of the concrete appears to vary.
 - 2) Determine the temperature of the concrete sample.
 - 3) Determine the slump according to the requirements of ASTM C 143/C 143M.
 - b. Acceptance Criteria:
 - 1) Refer to Paragraph 2.05.B.
3. Air Content Test:
- a. Test Procedure:
 - 1) Determine the air content of the concrete for each concrete strength test sample in accordance with ASTM C231, ASTM C173/C 73M, or ASTM C138/C138M.
 - b. Acceptance Criteria:
 - 1) The Program/Project Manager will determine acceptability based on the results.
4. Concrete Strength Test for New Concrete:
- a. To evaluate the potential strength and uniformity of new concrete, perform at least 5 strength tests for each specified mix design to represent the mix's strength.
 - b. Test Procedure:
 - 1) Secure composite samples in accordance with ASTM C172.
 - a) Obtain representative test samples from different batches of concrete on a truly random basis by selecting a test batch



- number at random before commencing the placement of concrete.
- b) When pumping or pneumatic equipment is used, obtain samples at the truck and discharge ends.
 - c) Take sufficient test samples to perform not less than 5 strength tests of two 28 day cylinders per test for each concrete mix design.
 - (1) Take samples for each concrete mix design not less than once a day, or not less than once for each 50 cubic yards of concrete, or not less than once for each 3000 square feet of surface area placed.
- 2) Mold at least 5 concrete test cylinders in strict compliance with the requirements of ASTM C31/C31M for each strength test, and cure the cylinders for a 24-hour initial curing period.
- a) Have a responsible representative from the Testing and Inspection Agency observe the making of the concrete test cylinders by the Contractor, and immediately thereafter pack them in a sturdy container furnished by the Contractor and approved by the Testing and Inspection Agency.
 - b) Surround the concrete test cylinders with wet sand or sawdust and protect them from freezing.
 - c) Sequentially number the concrete test cylinders and record the number, the date each cylinder was made, and the results of the slump test, air content, and the temperature for each sample on the proper form; forward the form to the Program/Project Manager, and then transport the cylinders to the testing laboratory where they will be cured in strict compliance with ASTM C31/C31M until the time of the test.
- 3) Each strength test will be conducted in accordance with ASTM C39/C39M as follows:
- a) One 6 inch by 12 inch size concrete cylinder from the same sample will be tested 7 days after the cylinders were made for information.
 - b) An additional two 6 inch by 12 inch size concrete cylinders from the same sample will be tested for acceptance 28 days after the cylinders were made.
 - c) Two 6 inch by 12 inch size concrete cylinders will be put on hold for 56 days and tested only when the running average of three concrete cylinder tests falls below the acceptance criteria.
 - d) The result of the strength test is the average of the compressive strength results for the 2 specimen cylinders tested at 28 days.
 - e) If one concrete test cylinder in a strength test manifests evidence of improper sampling, molding, or testing, it will be



discarded, and the strength of the remaining cylinder will be considered to be the test result; if both specimen cylinders in a test for a single sample show any of the above defects, the entire test for those samples will be discarded.

- c. Acceptance Criteria:
 - 1) The test results for standard molded and cured test cylinders will be evaluated separately for each specified concrete mix design by comparing the test results to the minimum requirements for the Class of concrete as specified in Article 2.02.
 - 2) The strength level of the concrete will be considered satisfactory so long as the average of all sets of 3 consecutive compressive strength test results equal or exceed the specified strength f'_c , and no individual strength test result falls below the specified strength f'_c by more than 500 psi.
- 5. Concrete Strength Test for Concrete in Place:
 - a. The Program/Project Manager will determine locations where the concrete in place is potentially deficient, and where to obtain test cores to least impair the structure's strength.
 - 1) As an aid to evaluate in place concrete strength or for selecting areas to be cored, the Program/Project Manager may permit concrete in place to be tested by impact hammer, sonoscope, or other nondestructive device to determine the relative strengths at various locations in the structure.
 - 2) The preliminary non-destructive tests of concrete in place will not be used as a basis for accepting or rejecting the concrete, rather the core testing will be the basis for accepting or rejecting the in-place concrete.
 - b. Concrete Core Test:
 - 1) Test Procedure:
 - a) The Program/Project Manager will determine the locations in each member or area of concrete in place where the required cores may be obtained.
 - b) At least 3 representative core samples will be taken from each member or area of concrete in place that is considered potentially deficient.
 - (1) Each core sample will be at least 3-inches in diameter.
 - (2) If the concrete in the structure will be dry under service conditions, the cores will be air dried for 7 days before the test at a temperature of 60 to 80 degrees Fahrenheit and a relative humidity of less than 60 percent; the cores will be tested dry.
 - (3) If the concrete in the structure will be more than superficially wet under service conditions, the cores will be tested after moisture conditioning them in accordance with ASTM C42/C42M.



- c) The core samples will be tested in accordance with ASTM C42/C42M.
 - (1) If one or more of the cores shows evidence of having been damaged before the testing, it must be replaced either subsequent to or during its removal from the structure.
 - d) Solidly fill core holes with low slump concrete.
 - 2) Acceptance Criteria:
 - a) Concrete in the area represented by a core test will be considered adequate if the average compressive strength of the cores is equal to at least 85 percent of the specified strength f'_c , and if no single core is less than 75 percent of the specified strength f'_c .
 - b) If the core tests fail to demonstrate concrete strengths adequate for the intended purpose of the member or members in question, or are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be required.
 - (1) The results will be evaluated in accordance with ACI 318/318R.
6. Inspections:
- a. Concrete Surface Irregularities:
 - 1) Evaluate floor flatness/levelness in accordance with criteria defined in Paragraph 3.03.H, in ASTM E1155, and on the Contract Drawings.
- B. Concrete Acceptance:
- 1. Completed concrete work which meets the specified requirements will be accepted without qualification.
 - 2. Completed concrete work which fails to meet one or more requirements but which has been repaired to be in compliance will be accepted without qualification.
- C. Non-Conforming Work
- 1. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in this Section.
 - a. The Phoenix Sky Harbor International Airport and the Program/Project Manager reserve the right to reject any or all items which do not meet the requirements of the Contract Drawings and Specifications.
 - b. Remove items determined to be non-conforming, and replace the non-conforming items removed with Work that conforms to the specified requirements.
 - 2. Concrete Compressive Strength:
 - a. If concrete fails to meet the minimum specified compressive strength test requirements, the concrete represented by such tests will be



considered questionable and subject to further testing and other requirements as follows:

- 1) Additional curing may be required as directed by the Program/Project Manager.
- 2) Modifications may be required for remaining concrete work, including changes in the concrete mix designs.
- 3) When the strength of the structure is considered potentially deficient by the Phoenix Sky Harbor International Airport and/or the Program/Project Manager, structural analysis and/or additional testing may be required.
 - a) If in the opinion of the Phoenix Sky Harbor International Airport and/or the Program/Project Manager there is cause for concern over the adequacy of the structure regardless of the results of any previous tests, additional tests of the hardened concrete may be required.
 - (1) The additional testing of questionable concrete will be conducted in accordance with the requirements of ASTM C42/C42M, except as noted in Subparagraph 3.05.C.2.a.3.a.2.
 - (2) If the initial test acceptance requirements had been met, the Contractor is not required to bear the costs of such additional tests unless their results confirm that the concrete in place is deficient.
3. Concrete Appearance:
 - a. Repair defects which adversely affect the appearance of the specified finish in concrete exposed to view if possible.
 - 1) If in the opinion of the Program/Project Manager the defect cannot be repaired, the concrete may be accepted or rejected as provided in this Section.
 - 2) Concrete not exposed to view is not subject to rejection for defective appearance.
4. Location of Members:
 - a. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected; or if the misplaced items interfere with other construction.
5. Dimensional Tolerances:
 - a. Inaccurately formed concrete surfaces which are exposed to view and do not conform to the requirements of ACI 117 may be rejected.
 - 1) Repair, or remove and replace, the section as required.
 - 2) If the outlines of formed concrete surfaces are smaller than required by an amount exceeding the requirements of ACI 117, they will be considered deficient in strength and subject to the provisions of Subparagraph 3.05.C.2.



- 3) If the outlines of formed concrete surfaces are larger than required by an amount exceeding the requirements of ACI 117, they may be rejected.
 - a) The Program/Project Manager may require that the excess material be removed.
 - b) If the excess material is to be removed, do so in a manner that maintains the strength of the section and meets the other applicable requirements of function and appearance.

3.06 CLEANING

- A. At the end of each day, clean and remove waste sandblasting material from the Work area.
- B. After fiber-reinforced concrete has reached its 28-day design strength, burn off the exposed excess fibers.

3.07 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
 1. Final Concrete Mix Design Submittal Form.
 2. Test Results Submittal Form.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.3, 1.02.C.10, 1.04B, 2.01.B	Add requirements for ENVISION Sustainability Rating System
2	03/02/2018	N/A	1.02.C	Correct Reference Standards
			3.03.E.5	Add Instructions

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM

(One for each required mix design)

PROJECT: _____ **Location:** _____

Contractor: _____

Mix design no.: _____ **Design strength:** _____

USE (Describe): _____

Mix Design Preparation: Based on Standard Deviation Analysis: _____

(check one) or Based on Trial Mixture Test Data: _____

MATERIALS:

Aggregates: (Provide size, type, source, specification)

Coarse: _____

Fine: _____

Cement Type/Source: _____

Admixtures: (Provide product, manufacturer)

Water Reducer (WR): _____

Air Entraining (AE): _____

Accelerator: _____

Other: _____

CONCRETE PROPERTIES

Water/Cement Ratio: _____

Slump: _____ inches

Entrained Air: _____ %

Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate: _____

Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement

W. R. _____ oz. per 100# cement

A. E. _____ oz. per 100# cement

Other _____ oz. per 100# cement

MIX PROPORTIONS

	Weight (lbs)	Absolute Volume (cubic feet)
Cement:	_____	_____

Fine Aggregate:	_____	_____
-----------------	-------	-------

Coarse Aggregate:	_____	_____
-------------------	-------	-------

Water:	_____	_____
--------	-------	-------

Entrained Air:	_____	_____
----------------	-------	-------

Other:	_____	_____
--------	-------	-------

TOTAL	_____	_____
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**TEST RESULTS SUBMITTAL FORM****METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318/318R, ACI 301):**

Number of Test Cylinders Evaluated: _____ Standard Deviation: _____

(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

$$f'_{cr} = f'_c + 1.34s = \text{_____} \text{ psi}$$

$$f'_{cr} = f'_c + 2.33s - 500 = \text{_____} \text{ psi}$$

$$\text{Actual } f'_c = \text{_____} \text{ psi } (\square f'_{cr})$$

$$\text{Slump} = \text{_____} \text{ in. } \quad \text{Air Content} = \text{_____} \%$$

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318/318R □ 5.3.2.2):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	=====	=====	=====
28-day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$$\begin{array}{ll} f'_{cr} = f'_c + 1200 \text{ psi} & (\text{for } f'_c \square 5000 \text{ psi or less}) \\ \text{or} & \\ f'_{cr} = f'_c + 1400 \text{ psi} & (\text{for } f'_c > 5000 \text{ psi}) \end{array}$$

$$\text{Slump} = \text{_____} \text{ in. } \quad \text{Air Content} = \text{_____} \%$$

REMARKS: _____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable).

SUBMITTED BY:

Ready-Mix Supplier: Name _____

Address: _____

Phone Number: _____



SECTION 03410

PLANT-PRECAST STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for plant manufactured precast concrete products
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
- C. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users..

1.02 REFERENCE STANDARDS:

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. Standard Specifications for Transportation Materials and Methods of Testing and Sampling:
 - a. AASHTO M 251 - Standard Specification for Plain and Laminated Elastomeric Bridge Bearings.
- B. American Concrete Institute (ACI):
 - 1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
- C. ASTM International (ASTM):
 - 1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
 - 2. ASTM A 82/A 82M – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 3. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.



4. ASTM A 536 - Standard Specification for Ductile Iron Castings.
5. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
6. ASTM A 706/A 706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
7. ASTM C 31/C 31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
8. ASTM C 33 - Standard Specification for Concrete Aggregates.
9. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
10. ASTM C 109/C 109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
11. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
12. ASTM C 150 - Standard Specification for Portland Cement.
13. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete.
14. ASTM C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
15. ASTM C 192/C 192M - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
16. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
17. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
18. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
19. ASTM C 942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
20. ASTM C 1064/C 1064M – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
21. ASTM D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
22. ASTM D 2240 – Standard Test Method for Rubber Property—Durometer Hardness.
23. ASTM C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
24. ASTM C858 – Standard Specification for Underground Precast Concrete Utility Structures.
25. ASTM C891 – Standard Practice for Installation of Underground Precast Utility Vault Structures
26. ASTM C1037 – Standard Practice for Inspection of Underground Precast Utility Vault Structures.

D. City of Phoenix (COP):

1. Phoenix Building Construction Code and Amendments.



- E. International Code Council (ICC):
 - 1. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- F. Precast/Prestressed Concrete Institute (PCI):
 - 1. PCI Plant Certification Program
 - 2. PCI MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
 - 3. PCI MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
 - 4. PCI MNL-135 – Tolerance Manual for Precast and Prestressed Concrete Construction.
- G. Institute for Sustainability Infrastructure (ISI)
 - 1. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing and inspections performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Provide 10 days notification prior to the time the precast concrete units will be available for plant inspection.
 - 2. Before concrete is to be placed, coordinate work that must support or be embedded in the concrete to allow embedded items to be introduced or furnished before the concrete is placed and not delay the Work.
- B. Sequencing:
 - 1. Sequence the erection of the precast utility vaults to be coordinated with construction of all utilities that attach to the vault.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Precast concrete unit anchorage, lifting inserts, and other devices
 - 2) Mechanical splice sleeves.
 - 3) Splice sleeve grout.
 - 4) Bearing pads.
 - 5) Accessory items.



- b. Shop Drawings:
 - 1) Precast concrete units.
 - c. Certificates:
 - 1) Material certifications.
 - d. Delegated Design Submittals:
 - 1) Precast concrete unit design calculations.
 - 2) Concrete mix design proportions and concrete mix design test data.
 - e. Special Procedure Submittals:
 - 1) Materials and methods proposed for repairing surface defects.
 - f. Qualification Statements:
 - 1) Precast concrete manufacturing plant's quality control procedures, or verification of the plant's current PCI Plant Certification.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's handling methods for the products.
 - 2) Installation instructions for precast concrete unit anchorage, lifting inserts, and other devices.
 - 3) Manufacturer's installation instructions for the precast concrete units.
 - 4) Installation instructions for accessory items.
 - 5) Manufacturer's instructions for mixing, placing, and curing splice sleeve grout.
 - b. Source Quality Control Submittals:
 - 1) Slump test reports.
 - 2) Compressive Strength test reports.
 - 3) Air Content test reports.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete



(100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:

- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.

2. Testing and Inspection Agency:

- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Plant-Precast Structural Concrete Manufacturer's Qualifications:

- a. Experience:
 - 1) Employ an experienced and acceptable precast concrete manufacturer to design and fabricate the precast concrete units.
 - 2) The precast concrete unit manufacturer must maintain a permanent quality control department, or retain an independent testing agency on a continuing basis.
 - a) If an independent testing agency has been retained, the agency must issue a report, signed and sealed by a Professional Engineer licensed in the State of Arizona, detailing the ability of the precast concrete manufacturer to produce quality units consistent with industry standards.
 - 3) Submit documentation showing the precast structural concrete manufacturer has been regularly and continuously engaged in manufacturing structural precast concrete similar to those required under this Contract for at least 5 years.
- b. Plant Certification Requirements:
 - 1) The precast manufacturer must be certified by the PCI Plant Certification Program and must meet the requirements of PCI MNL-116 and/or PCI MNL-117 as applicable.
 - 2) The precast manufacturer must have quality control procedures established in accordance with the PCI Plant Certification



- Program in place prior to and during production of the products for this Contract.
- 3) Submit the plant's quality control procedures demonstrating adherence to the PCI Plant Certification Program or verification of the plant's current PCI Plant Certification, to the Program/Project Manager for approval.
2. Professional Engineer Qualifications:
 - a. Have the precast concrete manufacturer employ a licensed Professional Engineer, registered in the State of Arizona, who has experience performing precast structural concrete calculations to design the standard precast concrete units and prepare Shop Drawings.
- C. Certifications:
1. Material Certifications:
 - a. Submit copies of material certifications and laboratory test reports from the precast concrete manufacturer for the Portland cement, pozzolans, aggregates, admixtures, and curing compound proposed for the Work of this Section.
 - b. For reinforcement steel material, submit certified copies of mill test reports to the Program/Project Manager that, as a minimum, contain the following information for approval:
 - 1) Heat number and identification.
 - 2) Standard chemical analysis for heat of steel.
 - 3) Ultimate tensile strength.
 - 4) Yield stress at 1 percent extension under load.
 - 5) Elongation of failure.
 - 6) Modulus of elasticity.
 - 7) Diameter and net area.
 - 8) Type of material.
- D. Site Samples:
1. If required by the Contract Documents, submit Samples of special concrete finishes and/or Samples of architectural concrete finishes to the Program/Project Manager for approval prior to starting production.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
1. Ensure adequate access to the Site is available to enable hauling, storage, and proper handling of the precast concrete units.
 2. Do not ship precast concrete units that do not meet the specified criteria.
 3. Transport precast concrete units in a manner that minimizes potential damage.



4. The Program/Project Manager will examine each precast concrete unit as it is delivered to the Site for quality and acceptance, and reject unacceptable units.
- B. Storage and Handling Requirements:
 1. Employ lifting methods and devices intended for the purpose as indicated on the approved Shop Drawings.
 - a. Submit manufacturer's information showing acceptable handling methods for the products.
 - b. Lift precast concrete units at points provided by the precast concrete manufacturer using suitable lifting devices.
 - c. Consistent with industry standards, furnish lifting devices having a minimum factor of safety of 4.
 - 1) Furnish reusable lifting hardware and rigging having a minimum factor of safety of 5.
 2. Store and handle precast concrete units in a manner that will minimize potential damage.
 - a. Do not place units directly on the ground.

PART 2 PRODUCTS

2.01 DESCRIPTION:

- A. Regulatory Requirements:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 2. Safety Requirements:
 - a. The Contractor is responsible for determining and implementing the procedures for erecting precast concrete members safely and that comply with the applicable regulations of the Federal, State, and local Authorities Having Jurisdiction.
- B. Sustainability Requirements:
 1. Sustainability Requirements:
 - a. Recycled Content
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 2) For each mix design, provide % of fly ash by weight and the total material value for each mix type used on the project.
 - b. Regional Content



- 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

2.02 DESIGN CRITERIA:

A. Concrete Compressive Strength:

1. Provide precast concrete units having a 28-day compressive strength (f'_c) =4000 PSI minimum, as indicated in the Contract Documents.

B. Precast Concrete Units:

1. Have the Professional Engineer employed by the precast concrete manufacturer perform the following tasks:
 - a. Design the precast concrete units to withstand the indicated design load conditions- Highway Rated or Aircraft Rated as specified in the Contract Documents.
 - 1) Consider stresses induced during shipping, handling, and installation in order to avoid product cracking or other handling damage.
 - b. Prepare design calculations for the precast concrete units.
 - 1) Design joints and sealants between adjacent units to meet the specified design and performance requirements.
 - 2) Include the complete analysis for lifting stresses, the sizing of lifting devices, and foundation attachment.
 - c. Determine the concrete mix design proportions.
 - 1) Submit a mix design for each strength and type of concrete to be used.
 - a) Include copies of concrete mix design test reports complying with the requirements of Section 4 in ACI 301 showing the mix has successfully produced concrete with the specified properties, and will be suitable for Contract conditions.
 - b) Provide the quantity, type, and brand of all mix design constituents in the design, and include applicable data sheets for each constituent.
 - d. Prior to fabricating the precast concrete units, prepare Shop Drawings for the precast concrete units showing complete design, installation, and construction information in such detail as to enable the Program/Project Manager to determine the adequacy of the proposed custom-made precast concrete units for the intended purpose.
 - 1) Include the design loads for the precast concrete units on the Shop Drawings.



- 2) Include details showing the size and placement of steel reinforcement.
 - 3) Indicate the type and configuration of joints and sealants between adjacent units.
 - 4) Include plans and elevations showing dimensions, connection details, finishes, openings, cast-in-place items, and the erection sequence.
 - 5) Include design calculations for the precast concrete connection to the foundation system unless otherwise noted.
2. Submit the precast concrete unit Shop Drawings and design calculations, prepared, stamped, and signed by the Professional Engineer, to the Program/Project Manager for approval.

2.03 MATERIALS:

A. Cement:

1. Provide Type I or II cement complying with the requirements of ASTM C 150.
2. For all exposed precast concrete use the same brand, type, and source of cement.

B. Normal Weight Concrete Coarse and Fine Aggregates:

1. Provide aggregates complying with the requirements of ASTM C 33.
2. Do not provide aggregates that contain substances which may be deleteriously reactive with the alkalis in the cement.

C. Admixtures:

1. Accelerating, Retarding, Water-Reducing Admixtures:
 - a. Provide accelerating, retarding, water-reducing (moderate to high) admixtures complying with the requirements of ASTM C 494/C 494M.

D. Water:

1. Provide water clean and free of injurious amounts of oils, acids, alkalis, salts, and other substances deleterious to concrete and concrete reinforcement..

E. Concrete Reinforcement:

1. Reinforcement Bars:
 - a. Deformed Billet-Steel:
 - 1) Provide deformed billet-steel reinforcing bars complying with the requirements for Grade 60 bars as specified in ASTM A 615/A 615M.
 - b. Deformed Low-Alloy Steel:
 - 1) Where welding of reinforcement is required, provide deformed low-alloy steel reinforcing bars complying with the requirements of ASTM A 706/A 706M.



2. Wire:
 - a. Provide plain wire complying with the requirements of ASTM A 82/A 82M.
- F. Inserts and Embedded Metal:
 1. Provide inserts and embedded metal items of the type required for the intended use that comply with the following:
 - a. Provide structural steel plates, angles, and other shapes complying with the requirements of ASTM A 36/A 36M.
 - b. Hot-dip galvanize items in accordance with the requirements of ASTM A 123/A 123M.
 - c. Provide proprietary items in accordance with the manufacturer's published literature.
 2. Mechanical Splice Sleeves:
 - a. Provide mechanical splice sleeves for embedment in precast concrete members that are designed to splice rebar in one precast member to rebar in adjacent members when the rebar in the adjacent member is inserted into the mechanical splice sleeve and injection grouted.
 - 1) Material: Ductile iron complying with the requirements specified in ASTM A 536.
 - 2) Splice Yield Point: Equivalent to a Type 2 connection as specified in ACI 318/318R.
 - 3) Geometry: Frusto-conical shape, equipped with both inlet and outlet grout ports and sleeves, and having an integral internal rebar stop midway along the sleeve.
 - b. Submit Product Data for the mechanical splice sleeves to the Program/Project Manager for approval.
 - c. Manufacturers:
 - 1) Splice Sleeve North America®, www.splicesleeve.com.
 - 2) Approved equal.
- G. Anchorage, Lifting Inserts, and Devices:
 1. For the precast concrete unit anchorage, lifting inserts, and other devices, submit Product Data sheets and proper installation instructions from the precast concrete manufacturer to the Program/Project Manager for approval.
 - a. Clearly indicate precast concrete unit dimensions.
 - b. Clearly indicate safe working loads.
- H. Bearing Pads:
 1. Provide neoprene bearing pads a minimum of 1/8 inch thick, and conforming to the requirements of Section 25 in AASHTO M 251 and the following:
 - a. Hardness (Minimum): Durometer 60 when measured in accordance with the requirements of ASTM D 2240.



- b. Ultimate (Breaking) Elongation: 350 percent when measured in accordance with the requirements of ASTM D 412.

I. Accessory Items:

- 1. For accessory items installed before or after the delivery of the precast concrete units, submit proper installation instructions and relevant Product Data to the Program/Project Manager for approval.

2.04 FABRICATION:

A. Shop Fabrication:

- 1. The precast concrete producer must conform to the requirements of the PCI Quality Control Manual for Precast Concrete Plants.
- 2. Concrete Forms:
 - a. Provide forms for manufacturing precast concrete units of the type and design consistent with industry standards and practices.
 - 1) Provide forms capable of consistently providing uniform products and dimensions.
 - 2) Construct the forms so the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.
 - b. Clean concrete build-up from the forms after each use.
 - c. Apply release agents to the forms according to the manufacturer's recommendations, but do not allow release agent to build-up on the form's casting surfaces.
- 3. Concrete Reinforcement:
 - a. For placing and splicing, conform to ACI 318/318R.
 - b. Provide concrete cover on the reinforcement as shown on the Contract Drawings.
 - c. Fabricate cages of reinforcement by tying the bars into rigid assemblies.
 - d. Position the reinforcing as specified by the design so the concrete cover conforms to the requirements.
 - e. Provide positive means to assure the reinforcement does not move significantly during the casting process.
 - f. Mechanical Splice Sleeve Installation:
 - 1) Insert embedded reinforcement steel bars to be spliced using mechanical splice sleeves into the splice sleeve until it reaches the rebar stop in the center of the splice sleeve.
 - 2) Secure the reinforcement steel bar and mechanical splice sleeve firmly in place using sleeve setters or other means to prevent displacement during concrete placement.
 - g. Do not use metal chairs in the finish face.
- 4. Embedded Items:
 - a. Position embedded items at the locations indicated in the Contract Documents and approved Shop Drawings.



- b. Hold inserts, plates, lifting devices, and other items to be embedded in the precast concrete rigidly in place so they do not move during casting operations.
- 5. Concrete:
 - a. Mixing Concrete:
 - 1) Perform mixing operations so the concrete produced is uniform in strength, consistency, and appearance.
 - b. Placing Concrete:
 - 1) Deposit conventional concrete in the forms as near to the final location as practical.
 - 2) Consolidate concrete so segregation of the concrete and the creation of honeycombed areas are minimized.
 - a) Furnish vibrators for consolidating the concrete having frequencies and amplitudes sufficient to produce well-consolidated concrete.
 - c. Curing Concrete:
 - 1) Commence curing operations immediately following the initial set of the concrete and of surface finishing.
 - 2) Using one of the following methods, prevent moisture from evaporating from exposed surfaces until adequate strength for stripping the precast concrete unit from the forms is reached:
 - a) Cover the concrete with polyethylene sheets using sheets as specified in ASTM C 171, or
 - b) Cover the concrete with burlap or another absorptive material and keep the material moist, or
 - c) Apply a membrane-curing compound as specified in ASTM C 309 at a rate not exceeding 200 square feet per gallon, or in accordance with the manufacturer's recommendations.
- 6. Openings for Utilities:
 - a. Utility Openings including manhole frame at top if needed.
 - 1) Provide all openings required for the utilities as shown in the Contract Documents.
- 7. Stripping Precast Concrete Units from Forms:
 - a. Do not remove precast concrete units from the forms until the concrete reaches the compressive strength required by the design for stripping.
 - b. If no such requirement exists, products may be removed from the forms after the final set of concrete provided stripping does not have an effect on performance or appearance of the final product.
 - 1) Routinely measure the stripping strengths to ensure the product has attained sufficient strength for safe handling.

B. Fabrication Tolerances:

- 1. Provide precast concrete units conforming to the unit tolerances specified in PCI MNL-135.



2.05 MIXES:

- A. Concrete Mix Design:
 - 1. Concrete Proportions:
 - a. Base the selection of concrete proportions on the methodology presented in ACI 211.1 for normal weight concrete.
 - b. Develop concrete proportions using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture.
 - c. Do not use accelerators containing calcium chloride in precast concrete containing reinforcing steel or other embedded metal items.
 - 2. Water-Cement Ratio:
 - a. Provide concrete mixes having a water-cement ratio of 0.45 or less.
 - 3. Air Content:
 - a. Provide concrete mixes having a total air content of 5 percent plus or minus 1 percent by volume.
- B. Splice Sleeve Grout:
 - 1. Provide high strength, nonshrink filler mortar specially formulated for Type 2 connections in accordance with the requirements of ACI 318/318R, and having 11,000 psi minimum strength at 28 days.
 - 2. Submit Product Data for the splice sleeve grout to the Program/Project Manager for approval.
 - 3. Submit the splice sleeve grout manufacturer's instructions for mixing, placing, and curing the grout to the Program/Project Manager for information.
 - 4. Manufacturers:
 - a. Splice Sleeve North America, SS Mortar® grout, www.splicesleeve.com.
 - b. BASF, www.buildingsystems.basf.com.
 - c. Approved equal.

2.06 FINISHES:

- A. Shop Finishing Methods:
 - 1. If no finishing procedure is specified, finish concrete surfaces using a strike-off at the level of the top of the form; otherwise finish unformed surfaces of precast concrete products as specified:
 - a. Formed Non-Architectural Surfaces:
 - 1) Cast surfaces against approved forms in accordance with standard industry practices for cleaning forms, designing concrete mixes, placing concrete, and curing concrete.
 - 2) Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted.



- 3) Major imperfections, excessive honeycombing, and other major defects are unacceptable.
- b. Unformed Surfaces:
 - 1) Finish unformed surfaces with a vibrating screed, or by hand with a float.
 - 2) Normal color variations, minor indentations, and minor chips and spalls will be accepted.
 - 3) Major imperfections, excessive honeycombing, and other major defects are unacceptable.
- c. Special Finishes:
 - 1) Provide troweled, broom, or other finishes in accordance with the Contract Documents.
 - 2) Perform the finishing in accordance with industry standards or supplier specifications.

2.07 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. During the period when precast concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders for the sole use of the Testing and Inspection Agency and the code-required Approved Agency.
 - c. Provide containers for transporting concrete test cylinders to the testing laboratory.
 - 2. Tests:
 - a. The precast concrete manufacturer must demonstrate the following quality control tests are performed as required in accordance with the specified ASTM International standards by submitting test reports documenting compliance with the following tests:
 - b. Slump Test:
 - 1) Test Procedure:
 - a) Perform a slump test in accordance with the requirements of ASTM C 143/C 143M either for each 50 cubic yards of concrete produced for each mix design, or once a day, whichever comes first.
 - 2) Acceptance Criteria:
 - a) Slump of up to 4 inches is acceptable unless a high range reducing admixture is used, in which case slump up to 8 inches is acceptable.



- c. Compressive Strength Test:
 - 1) Test Procedure:
 - a) For each mix design, perform a compressive strength test on at least 4 specimens for each 50 cubic yards of concrete produced for each mix design.
 - (1) Test 2 cylinders at 7 days and 2 cylinders at 28 days.
 - b) Perform a compressive strength test in accordance with the requirements of ASTM C 39/C 39M.
 - 2) Acceptance Criteria:
 - a) Mixes having the 28-day compressive strength (f'_c) as specified in Subparagraph 2.03.A.1 are acceptable.
 - d. Air Content Test:
 - 1) Test Procedure:
 - a) Perform an air content test in accordance with the requirements of either ASTM C 231 or ASTM C 173/C 173M for each 50 cubic yards of concrete produced for each mix design, but not less than once a day.
 - 2) Acceptance Criteria:
 - a) Concrete having the air content as specified in for each mix design as specified in Subparagraph 2.05.A.3.a are acceptable.
 - 3. Inspections:
 - a. The Program/Project Manager or Approved Agency may place an Inspector in the precast concrete unit manufacturing plant when the units provided under this Section are being manufactured.
- B. Non-Conforming Work:
- 1. Repairing Minor Defects:
 - a. Products having defects that will not impair the functional use or expected life of a precast concrete unit may be repaired by an approved method that does not impair the product.
 - 1) Formed surfaces relatively free of air voids and honeycombed areas do not require patching and repair unless the surfaces are required to be finished by the design or are exposed to public view.
 - 2) Submit the materials and methods proposed for repairing surface defects to the Program/Project Manager for approval.
 - 2. Repairing Honeycombed Areas:
 - a. Where honeycombed areas are to be repaired, remove all loose material and cut back the areas to essentially horizontal or vertical planes.
 - 1) Cut back the areas to a depth where coarse aggregate particles break under chipping rather than being dislodged.
 - b. Use proprietary repair materials in accordance with the manufacturer's instructions to fill the depression.



- c. If proprietary repair materials are not used, saturate the area with water immediately prior to starting the repair.
 - 1) Make sure the repair area is damp, but free of excessive water.
 - 2) Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.
 - 3. Repairing Major Defects:
 - a. Have qualified personnel evaluate defects in precast concrete products which impair the functional use or the expected life of the products to determine if repairs are feasible, and if so, to establish the repair procedure.
 - 4. Finish Requirements:
 - a. Repair and patching work must comply with finish requirements of the Contract for the item.
 - 1) Colors of repaired and patched work must reasonably match the colors specified for the work and/or surrounding areas.
- C. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when concrete for this Contract is being mixed, placed, and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify the structure and anchorage inserts for the precast members to be placed are within the allowable tolerances.
- B. Evaluation and Assessment:
 - 1. Notify the Program/Project Manager of out of tolerance anchorage inserts for the precast members.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Erect adequate barricades, warning lights, and/or signs to safeguard traffic in the immediate area of hoisting and handing operations.

3.03 ERECTION

- A. Erect precast concrete units to the lines and grades indicated in the Contract Documents or as otherwise specified.



- B. Fasten the precast concrete units in place in accordance with the approved Shop Drawings.
 - 1. Submit the precast concrete unit manufacturer's installation instructions to the Program/Project Manager for information.
- C. Furnish and maintain temporary bracing in place for the precast concrete units until final support and bracing is provided to maintain position, stability, and alignment.
- D. Special Techniques:
 - 1. Field modifications to the precast concrete units are not allowed unless approved by the precast unit manufacturer and the Program/Project Manager.
 - 2. Mechanical Splice Sleeve Installation:
 - a. Insert the end of rebar to be spliced into the mechanical splice sleeve to the rebar stop in the center of the splice sleeve side of the splice.
 - b. Temporarily brace the erected precast elements prior to injecting splice sleeve grout into the inlet grout sleeve and port.
 - c. Follow the grout manufacturer's instructions for mixing, placing, and curing the grout.
 - 1) Prior to pumping grout into the mechanical splice sleeve, continuously pour grout into the mechanical splice sleeve to eliminate air pockets.
 - a) Visually inspect the pocket to verify the sleeve is filled with grout, and use a wire to stir the grout to remove entrapped air.
 - 2) Inject the grout into the inlet grout sleeve using a low pressure pump, and insure the grout completely fills the space in the mechanical splice sleeve by observing grout flowing freely without air bubbles from the outlet grout sleeve.
 - 3) Following the grouting operation, remove the pump and seal the grout injection point and air release point with rubber stoppers to avoid loss of grout.
- E. Tolerances:
 - 1. Furnish, erect, and interface precast concrete members within the tolerances specified for the applicable element type in PCI MNL-135.

3.04 REPAIR / RESTORATION

- A. The repair of damage occurring to the precast concrete units after installation is the responsibility of the Contractor.
 - 1. Repairs made to exposed surfaces must match the color and texture of the surrounding concrete.



- B. The Contractor is responsible for any chipping, spalling, or other damage to the Work discovered at the Site, unless the damage occurred during storage by others.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when precast concrete is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform testing and inspections.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Cooperate with the Testing and Inspection Agency and code-required Approved Agency to facilitate their testing and inspections.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Splice Sleeve Grout Test:
 - a. Test Procedure:
 - 1) Prior to approving each batch of splice sleeve grout for use, four 2-inch cube specimens of grout from the batch must first be sampled, fabricated, stored, and cured in accordance with the requirements specified in ASTM C 109/C 109M and ASTM C 942.
 - 2) In accordance with the requirements specified in ASTM C 109/C 109M and ASTM C 942, the compressive strength of the grout will be determined by testing one cube specimen at 7 days, two cube specimens at 28 days, and one cube specimen at 56 days, if required.
 - b. Acceptance Criteria:
 - 1) Grout having a minimum compressive strength equal to the strength specified in Subparagraph 2.05.B.1.c is acceptable.
3. Inspections:
 - a. Observe the lines and grades of installed units to verify they are correct.

B. Non-Conforming Work:

1. Notify the precast concrete erector of observed discrepancies between the lines and grades of installed units and those indicated in the Contract Documents so corrective action can be taken.



3.06 CLEANING

- A. Clean soiled precast concrete surfaces, taking care to prevent damage to the surfaces and surrounding materials.

3.07 PROTECTION

- A. Immediately after the precast concrete units are erected, protect the units from damage.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First edition.





SECTION 03434

PRESTRESSED CONCRETE U-BEAMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for prestressed concrete U-beams, including providing the precast concrete beams; furnishing, placing, and tensioning prestressing steel; and pressure grouting the ducts enclosing the prestressing steel, in accordance with the details shown on the Contract Drawings.
 - a. Prestress the precast concrete members using the pretensioning method.
2. Requirements for furnishing and installing additional items required by the particular prestressing system used.
 - a. Such items as ducts, anchorage assemblies, and grout used for pressure grouting the ducts for post-tensioning systems as required and specified in Section 03250, Post-Tensioning; and strand deflection devices such as hold-downs and hold-ups for pretensioning systems are examples.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 03200 - Reinforcing Steel.
3. Section 03300 - Cast-In-Place Concrete.
4. Section 03410 - Plant-Precast Structural Concrete.

1.02 REFERENCES

A. Definitions:

1. Basic Anchorage Device: A prestressing tendon anchorage device that meets the restricted bearing compressive strength limits and minimum plate stiffness requirements specified in Article 9.7.2, Bridges Composed of Simple-Span Precast Prestressed Girders Made Continuous, appearing in Division I, Design, of the AASHTO Standard Specifications for Highway Bridges.
2. Special Anchorage Device: A prestressing tendon anchorage device that must be proven experimentally by meeting the acceptance criteria for the standardized acceptance test specified in Article 10.3.2.3, Special Anchorage Device Acceptance Test, appearing in Division II, Construction, of the AASHTO Standard Specifications for Highway Bridges.

B. Reference Standards:



1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO Standard Specifications for Highway Bridges.
 - b. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing.
 - 1) AASHTO M 194M/M 194 - Standard Specification for Chemical Admixtures for Concrete.
 - 2) AASHTO M 203M/M 203 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement.
 - 3) AASHTO M 204M/M 204 – Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.
 - 4) AASHTO M 275M/M 275 - Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete.
2. American Concrete Institute (ACI):
 - a. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
3. ASTM International (ASTM):
 - a. ASTM A 416/A 416M – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - b. ASTM A 421/A 421M – Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.
 - c. ASTM A 722/A 722M – Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
 - d. ASTM C 31/C 31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - e. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - f. ASTM C 150 - Standard Specification for Portland Cement.
 - g. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - h. ASTM C 494/CA 494M – Standard Specification for Chemical Admixtures for Concrete.

C. Precast/Prestressed Concrete Institute (PCI):

1. PCI MNL-135 – Tolerance Manual for Precast and Prestressed Concrete Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program Manager and the Phoenix Sky Harbor International Airport to insure that notification is received by them sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.



- a. Provide 10 days notification prior to the time the precast concrete units will be available for plant inspection.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Precast concrete unit anchorage.
 - 2) Precast concrete unit lifting inserts.
 - 3) Other Precast concrete unit devices.
 - 4) Precast concrete unit accessory items.
 - b. Shop Drawings:
 - 1) Shop Drawings of the proposed prestressed precast concrete U-beams.
 - c. Certificates:
 - 1) Certificate of Analysis for the Portland cement used in the grout mix.
 - 2) Calibration certifications for the jacking system.
 - d. Delegated Design Submittals:
 - 1) Design calculations for the proposed prestressed precast concrete U-beams.
 - 2) Graph for the jacking system showing the gauge pressure and force plotted for the tensioning calibration range.
 - e. Qualification Statements:
 - 1) Professional Engineer's qualifications.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Concrete mix designs, and concrete mix design test data.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's handling methods for the products.
 - 2) Installation instructions for the precast concrete units.
 - 3) Installation instructions for precast concrete unit anchorage
 - 4) Installation instructions for precast concrete unit lifting inserts.
 - 5) Installation instructions for other precast concrete unit devices.
 - 6) Installation instructions for precast concrete unit accessory items.
 - c. Site Quality Control Submittals:
 - 1) Force/elongation records of the tensioning process.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- B. Qualifications:
 - 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
 - 2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements
 - 3. Professional Engineer Qualifications:
 - a. Have the precast concrete manufacturer employ a licensed Professional Engineer, registered in the State of Arizona, who has experience performing structural concrete calculations for prestressed precast concrete to design the precast concrete U-beams and appurtenances and to prepare the required Shop Drawings.
 - b. Submit the Professional Engineer's qualifications to the Program Manager for approval.
- C. Certificates:
 - 1. Portland Cement:
 - a. Submit a Certificate of Analysis for the Portland cement used in the grout mix.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Do not ship precast concrete units if damage impairing the performance of the product could result.
 - 2. Transport precast concrete units in a manner that will minimize potential damage.
 - 3. Deliver precast concrete units to the Site in accordance with the approved delivery schedule to avoid excessive build-up of units in the storage area at the Site.



4. The Inspector will inspect each precast concrete unit as it is delivered to the Site for quality and acceptance.
5. All prestressing steel, anchorage assemblies, and bar couplers without proper lot numbers found at the Site will be rejected.

B. Storage and Handling Requirements:

1. Employ lifting methods and devices intended for the purpose as indicated on the approved Shop Drawings.
 - a. Submit manufacturer's information that shows acceptable handling methods for the products.
 - b. Lift precast concrete units at points provided by the precast concrete manufacturer using suitable lifting devices.
 - c. Consistent with industry standards, furnish lifting devices having a minimum factor of safety of 4.
 - 1) Furnish reusable lifting hardware and rigging having a minimum factor of safety of 5.
2. Store and handle precast concrete units and materials in a manner that will minimize potential damage.
 - a. Do not place precast concrete units directly on the ground.
 - b. Store Portland cement so it is protected from dampness.
 - 1) Do not use cement which has become partially set or which contains caked lumps.
3. Prohibitions:
 - a. Do not perform any welding near the prestressing steel or ducts unless it is indicated on the Contract Drawings, or directed by the Program Manager.
 - b. Do not locate a welding ground near the prestressing steel or ducts.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Hot Weather Grouting:
 - a. If during grouting operations hot weather conditions could contribute to too quick stiffening of the grout, prevent blockages during grout pumping operations by cooling the grout using approved methods.
 - b. To increase grout pumping efficiency and/or set time, the inclusion approved chemical admixtures in the grout is allowed.
2. Cold Weather Grouting:
 - a. If during and following grouting operations freezing weather conditions could prevail, provide adequate means to protect the grout in the ducts from damage caused by freezing.



PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Description:

1. Prestressed concrete U-beams consist of precast concrete structural members that have prestressing steel enclosed in pressure grouted ducts embedded in the beams or non-enclosed strands embedded in the beams as indicated on the Contract Drawings.
2. Additional components of the prestressed concrete U-beams required by the particular prestressing system and, if required, shop post-tensioning system used include anchorage assemblies and strand deflection devices such as hold-downs and hold-ups for the pretensioning systems.
3. Precast Concrete U-Beams:
 - a. Have the manufacturer's Professional Engineer perform the following tasks:
 - 1) Design precast concrete units as indicated in the Contract Documents and capable of withstanding the indicated design load conditions.
 - a) Prepare design calculations for the proposed precast concrete beams.
 - (1) Indicate the tensioning of the strands.
 - (2) Indicate the elongation of the strands at the time of jacking.
 - (3) During the design of the precast concrete U-Beams, consider the stresses induced during shipping, handling, and installation in order to avoid product cracking or handling damage.
 - (a) Include a complete analysis of lifting stresses, the sizing of lifting devices, and foundation attachment.
 - (b) Clearly indicate safe working loads.
 - b) Design joints and sealants between adjacent units to meet the specified design and performance requirements.
 - 2) Determine the concrete mix design proportions.
 - a) Submit a mix design for each strength and type of concrete that will be used.
 - (1) Include the mix's 28-day compressive strength, air content, and slump.
 - (2) Provide the quantity, type, and brand of all mix design constituents in the design, and include applicable Product Data for each constituent.
 - (3) Include copies of supporting concrete mix design test reports showing the mix has successfully produced concrete with the specified properties, and will be suitable for Contract conditions.



- 3) Prior to releasing the precast concrete beam design for fabrication, have the manufacturer's Professional Engineer prepare, seal, sign, and submit Shop Drawings, design calculations, and manufacturer's installation instructions for the proposed precast concrete beams to the Program Manager for approval.
 - a) Show complete design, installation, and construction information in sufficient detail to enable the Program Manager to determine whether or not the beams conform to the original design intent.
 - b) Indicate the type, size, number, and properties of the strands.
 - c) Indicate the sizes, shapes, dimensions, placement, and concrete cover of steel reinforcement.
 - (1) Include reinforcing steel required to be relocated or added to existing structures.
 - d) Show the locations and the harping points of the strands, and identify the type of finish or surface condition on the top of the precast U-beams.
 - e) Show the method and procedure for jacking the strands.
 - f) Indicate the type and configuration of joints and sealants between adjacent units.
 - g) Indicate the design loads for the precast concrete units.
 - h) Show precast concrete U-Beam dimensions, connection details, openings, and the erection sequence.
 - i) Include composite scale drawings with plan, elevation, and section views that show the relative positions of all embedded items and their embedment depths for both the prestressed elements and the other Work that is associated with these elements.
 - (1) Embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, reinforcing steel, anchor bolts, earthquake restrainers, deck joint assemblies, drainage systems, utility conduits, and other similar items.
 - j) Include details of supplemental steel that remains as part of finished product.
4. Anchorage Devices:
 - a. Provide either basic or special anchorage devices designed to satisfy the anchor efficiency requirements of Article 10.3.2, Post-Tensioning Anchorages and Couplers, as specified in Division II, Construction, of the AASHTO Standard Specifications for Highway Bridges.
 - 1) The anchor efficiency test specified must be performed by an approved independent testing and inspection agency acceptable to the Program Manager.
 - b. Basic Anchorage Devices:



- 1) If basic anchorage devices are provided, design the anchorage device and determine the required strength of the concrete in which it is to be embedded.
- c. Special Anchorage Devices:
 - 1) If special anchorage devices are provided, they must satisfy the acceptance test requirements of both Articles 9.21.7.3, Special Anchorage Devices, appearing in Division I, and 10.3.2.3, Special Anchorage Device Acceptance Test, appearing in Division II, Construction, of the AASHTO Standard Specifications for Highway Bridges.
 - a) The special anchorage device acceptance test must be performed by an approved independent testing and inspection agency acceptable to the Program Manager.
 - (1) Submit test records of the special anchorage device acceptance test to the Program Manager for approval.
 - d. Submit Product Data sheets and proper installation instructions for the precast concrete U-Beam anchorage, lifting inserts, and other devices to the Program Manager for approval.
5. Accessory Items:
 - a. Submit Product Data sheets and proper installation instructions for the accessory items, installed before or after delivery of the precast concrete units, to the Program Manager for approval.
- B. Design Criteria:
 1. Precast Concrete:
 - a. Concrete Compressive Strength
 - 1) Provide precast concrete units having a 28-day compressive strength (f'_c) as noted on the Contract Drawings.
 - b. Provide the auxiliary and confining reinforcement, minimum edge distance, minimum anchor spacing, and minimum concrete strength at the time of stressing as indicated in the Contract Documents.
 - c. Provide precast concrete units conforming to the unit tolerances specified in PCI MNL-135 for the element, erection, and interfacing.
 2. Stresses in the Prestressing Steel:
 - a. Unless otherwise indicated in the Contract Documents, stresses in the prestressing steel may not exceed those specified in the AASHTO Standard Specifications for Highway Bridges.
 - 1) Consider the working force to be the force remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, losses in prestressing steel due to sequence of stressing, friction, and all other losses peculiar to the method or system of prestressing, have taken place or have been provided for.
- C. Materials:
 1. Anchorage Devices:



- a. Provide either basic or special anchorage devices as indicated in the Contract Documents.
- b. Provide anchoring devices capable of holding the prestressing strands with a minimum of differential slippage.
2. Ducts:
 - a. Provide duct enclosures for post-tensioning steel fabricated from rigid galvanized ferrous metal, and that have sufficient strength to maintain their correct alignment during the placing of concrete.
 - b. Fabricate Ducts with either welded or interlocked seams.
 - 1) Seams and transition couplings connecting ducts to anchoring devices do not need to be galvanized.
 - 2) Provide positive metallic connections at joints between sections of duct that do not result in angle changes at joints.
 - 3) Tape all connections using waterproof tape.
 - c. Provide ducts and/or anchorage assemblies with pipes or other suitable connections that will allow grout to be injected into the duct after prestressing operations are completed.
3. Portland Cement Concrete:
 - a. Provide Portland cement concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete, for the class indicated in the Contract Documents.
4. Prestressing Steel:
 - a. Provide prestressing steel that complies with the requirements of AASHTO M 204M/M 204.
 - 1) Provide high-tensile steel wire, high-tensile seven-wire strand, or high-tensile alloy bars as indicated on the Contract Drawings.
 - a) High-tensile steel wire:
 - (1) Provide high-tensile steel wire complying with the requirements specified in AASHTO M 204M/M 204 (ASTM A 421/A 421M).
 - b) High -tensile seven-wire strand:
 - (1) Provide high-tensile seven-wire strand complying with the requirements for Grade 270 specified in AASHTO M 203M/M 203 (ASTM A 416/A 416M).
 - (2) In addition to the 0.5 inch diameter prestressing steel shown on the Contract Drawings, 0.6 inch diameter seven-wire strand may be used for cast-in-place structures.
 - c) High -tensile alloy bars:
 - (1) Provide high-tensile alloy bars complying with the requirements specified in AASHTO M 275M/M 275 (ASTM A 416/A 416M).
 5. Reinforcing Steel:
 - a. Provide reinforcing steel that complies with the requirements of Section 03200, Reinforcing Steel.



6. Debonding Material (Sheathing):
 - a. Provide debonding material consisting of tubular, non-slit, high-density plastic sheathing with a minimum wall thickness of 0.025 inch, and an inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch.
 - b. Provide debonding material which does not react with concrete, coating, or steel; and will prevent the intrusion of water or cement paste during concrete placement.

D. Shop Fabrication:

1. Jacking Equipment:
 - a. Furnish hydraulic jacks equipped with either a pressure gauge or load cell capable of determining the jacking force of the jack.
 - 1) Use either single strand or multiple strand jacks to tension the prestressed members.
 - 2) Calibrate both the jack and its gauge as a unit, and furnish a certified calibration chart for each unit.
 - a) Submit the latest calibration certifications for the jacking system to the Program Manager with the design calculations for information.
 - b) Calibration certifications for the jacking system older than 6 months are unacceptable.
 - 3) Furnish pressure gauges having either a 6-inch diameter reading dial or a digital display indicator.
 - a) Visibility: Readable by a person with normal vision at a distance of 10 feet.
 - b) Gauge Load Accuracy: Within one percent of the load throughout the entire range of the gauge.
 - c) Reading Dial Increments: No more than 2 percent of the jacking force.
 - b. Submit a graph showing the gauge pressure in pounds per square inch and force in thousands of pounds for the jacking system plotted through the entire range of the tensioning calibration.
2. Strand Splicing:
 - a. Splicing of strands is permitted, but splicing is not allowed within a member.
 - b. Only one splice per strand is allowed.
 - c. Strands to be spliced must have the same lay or direction of twist.
3. Stringing Prestressing Steel:
 - a. Limit the rotation of each strand to one revolution per 100 feet of exposed strand.
 - b. Do not incorporate the lengths of strand having points that have been previously gripped in anchoring devices within the following lengths of strand being strung.
4. Tensioning Prestressing Steel:



- a. At the time of its installation and tensioning, satisfactorily protect the prestressing steel from damage by abrasion, moisture, rust, or corrosion; and make sure the prestressing steel is free of dirt, rust, oil, grease, and other deleterious substances.
- b. Using hydraulic jacks, tension the prestressing steel so that the force in the prestressing steel is not less than the value shown on the Contract Drawings.
 - 1) Conduct the tensioning process so that the force applied to the prestressing steel and the elongation of the prestressing steel will be measured at all times during the process.
 - a) Keep a record of the prestressing force applied and the associated elongations measured during the entire tensioning process.
 - b) Submit the force/elongation records of the tensioning process to the Program Manager for information.
 - 2) Apply the jacking force to the prestressing steel in 2 increments:
 - a) Apply an initial force to the strands to straighten them, eliminate slack, and provide a starting reference point for measuring elongation.
 - b) Then apply the pretensioning force, and measure the elongation.
 - c) Compare the actual elongation measured during application of the calibrated jacking force to the theoretical calculated elongation.
 - (1) If the actual measured elongation differs from the theoretical calculated elongation by more than 5 percent, do not proceed with the tensioning until the tensioning procedure is checked and the source of the error is determined and corrected.
5. Precast the concrete for the prestressed concrete U-beams in accordance with the requirements of Section 03410, Plant-Precast Structural Concrete, except use the materials and additional procedures specified in this Section.
 - a. Do not transfer the tensioning force in the pretensioned strands to the precast member until the concrete strength, determined by performing concrete strength test on concrete specimens made and cured under the same conditions as the precast member, has attained the compressive release strength required.
 - 1) The tests will be performed by the Testing and Inspection Agency and/or the code-required Approved Agency.
 - 2) The transfer of the tensioning force in the pretensioned strands to the precast member is considered the end of the curing period.
 - b. If the concrete has not been placed within 72 hours of the tensioning of the prestressing strands, re-tension the strands prior to placing the concrete.



- c. If so ordered by the Program Manager, no more than 3 hours prior to placing the concrete for the member those prestressing strands that were individually tensioned may be checked for loss of force.
 - 1) Re-tension all strands showing a loss of prestress greater than 3 percent to the original jacking force.
- 6. Detension the strands following the curing period by releasing the strands from one or both ends of the casting bed depending on which method will produce the least movement of members in the casting bed and the least horizontal eccentricity of the initial prestressing force in the member.
 - a. If the concrete has been heat-cured, detension the strands immediately following the curing period.
- 7. Cut off all projecting strands that are not scheduled to remain for future embedment.
 - a. Cut and bend the strands scheduled to remain to the dimensions shown on the Contract Drawings.
 - b. If the end of the prestressed concrete U-beam will not be embedded in cast-in-place concrete, cut all strands or grind them flush with the surface of the concrete; and thoroughly coat them with a bitumastic type sealant.
- 8. Debonded Strands
 - a. Extend debonding material for debonded prestressing steel through the header.
 - b. Tie and tape the debonding material at the terminus inside the member.
 - c. Within 48 hours of detensioning the steel, seal the openings between the strand and the sheathing for the debonded strands with a 100 percent silicone sealant.
 - d. Do not use strands debonded over the full length of the U-beam.
- 9. Clean concrete laitance and other foreign matter from exposed uncoated reinforcing bars and strand.
 - a. If concrete laitance has hardened and other foreign matter remains on the bars, use abrasive blast methods to clean the bars.
 - b. On exposed epoxy-coated reinforcing steel, limit cleaning methods to those that do not damage the coating.
 - 1) Complete cleaning these bars while the concrete laitance is still plastic.
 - 2) Repair damage to the epoxy coating to the satisfaction of the Program Manager.

E. Mixes:

- 1. Grout Mix:
 - a. Provide cement grout consisting of no more than 5 gallons of water to one 94-pound bag of Portland cement.
 - 1) Portland Cement:
 - a) Provide Portland cement complying with the requirements for Type II specified in ASTM C 150.



- b) The cement may not contain more than 0.60 percent total alkali, which consists of the sum of sodium oxide and potassium oxide calculated as sodium oxide.
- c) Do not intermingle or use cement of different brands or types in the same batch.
- 2) Water:
 - a) Provide water free from injurious amounts of oil, acid, alkali, clay, vegetable matter, silt, and other harmful matter.
 - b) Do not use water containing more than 1000 ppm of Chlorides as Cl, or of sulphates as SO₄.
- b. Including a chemical admixture that complies with the requirements of AASHTO M 194M/M 194 (ASTM C 494/CA 494M) and is approved by the Program Manager in the grout is allowed.
 - 1) Do not use admixtures containing chlorides or nitrates.

F. Finishes:

- 1. Shop Finishing Methods:
 - a. Finish and patch the precast concrete surfaces as indicated on the Contract Drawings and specified in Section 03300, Cast-In-Place Concrete.
 - 1) After patching surfaces exposed to view, apply a rubbed finish, and use a mortar "lather" matching the color of the surrounding surface to produce a thin film on the surface.
 - 2) Once light dust appears, brush or sack the surface in one direction to produce a uniform texture and color.
 - b. Unless otherwise shown on the Contract Drawings, roughen the top surface of the prestressed concrete U-beams using a hand tine rake while the concrete is still plastic.

2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. During the period when concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders on the Site for the sole use of the Testing and Inspection Agency and the code-required Approved Agency.
 - c. Provide containers for transporting concrete test cylinders to the testing laboratory.



- d. The Testing and Inspection Agency and the code-required Approved Agency must perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required by failure of material to meet specified requirements.
 - e. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Concrete Strength Test:
- a. To evaluate the potential strength and uniformity of the precast concrete, at least 5 strength tests will be performed for each prestressed concrete U-beam to represent the beam's strength.
 - b. Test Procedure:
 - 1) Composite samples will be secured in accordance with ASTM C 172.
 - a) Representative test samples will be obtained from different batches of concrete on a truly random basis by selecting a test batch number at random before commencing the placement of concrete.
 - b) When pumping or pneumatic equipment is used, samples will be obtained at the truck and discharge ends.
 - c) Sufficient test samples to perform not less than 5 strength tests of two 28-day cylinders per test will be taken for each concrete mix design.
 - (1) Samples for each concrete mix design will be taken not less than once a day, or not less than once for each 100 cubic yards of concrete placed.
 - 2) At least 4 concrete test cylinders will be molded in strict compliance with the requirements of ASTM C 31/C 31M for each strength test, and the cylinders will be cured for a 24-hour initial curing period.
 - a) A responsible representative from the Quality Assurance Testing and Inspection Agency will make the concrete test cylinders, and immediately thereafter pack them in a sturdy container furnished by the Contractor and approved by the Quality Assurance Testing and Inspection Agency.
 - b) Surround the concrete test cylinders with wet sand or sawdust and protect them from freezing.
 - c) The concrete test cylinders will be sequentially numbered and the number, the date each cylinder was made, and the results of the slump test and the temperature for each sample on the will be recorded on the proper form, and the concrete test cylinders will be transported to the testing laboratory where



they will be cured in strict compliance with ASTM C 31/C 31M until the time of the test.

- 3) Each strength test will be performed in accordance with ASTM C 39/C 39M as follows:
 - a) 2 concrete test cylinders from the same sample will be tested 7 days after the cylinders were made for information.
 - b) 2 additional concrete test cylinders from the same sample will be tested 28 days after the cylinders were made for acceptance.
 - c) The compressive strengths of the two specimen cylinders tested at 28 days will be averaged.
 - d) If one concrete test cylinder in a strength test manifests evidence of improper sampling, molding, or testing, it will be discarded and the strength of the remaining cylinder will be considered to be the test result; if both specimen cylinders in a test for a single sample show any of the above defects, the entire test for that sample will be discarded.
- c. Acceptance Criteria:
 - 1) The test results for standard molded and cured test cylinders will be evaluated separately for each prestressed concrete U-beam by comparing the test results to the minimum requirements for the Class of concrete as specified.
 - 2) The strength level of the concrete will be considered satisfactory so long as the average of all sets of 3 consecutive compressive strength test results equal or exceed the specified strength f'_c , and no individual strength test result falls below the specified strength f'_c by more than 500 psi.
3. Inspections:
 - a. Record and submit force/elongation records of the tensioning process to the Program Manager for information.
 - b. The Program Manager may verify the accuracy of the certified calibration charts for the jacking equipment using its own load cells.
 - 1) If the certified calibration for the jacking equipment is found to be in error, immediately discontinue tensioning operations being performed by that equipment until a new certified calibration chart is produced.
- B. Non-Conforming Work:
 1. Repairing Minor Defects:
 - a. Products having defects that will not impair the functional use or expected life of a precast concrete beam may be repaired by any method that does not impair the product.
 2. Repairing Honeycombed Areas:
 - a. Where honeycombed areas are to be repaired, remove all loose material and cut back the areas to essentially horizontal or vertical planes.



- 1) Cut back the areas to a depth where at which coarse aggregate particles break under chipping rather than being dislodged.
 - b. Use proprietary repair materials in accordance with the manufacturer's instructions to fill the depression.
 - c. If proprietary repair materials are not used, saturate the area with water immediately prior to starting the repair.
 - 1) Make sure the repair area is damp, but free of excessive water.
 - 2) Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.
 3. Repairing Major Defects:
 - a. Have qualified personnel evaluate defects in precast concrete products which impair the functional use or the expected life of the products to determine if repairs are feasible, and if so, to establish the repair procedure.
- C. Coordination of Other Tests and Inspections:
1. Notify the code-required Approved Agency responsible for performing special inspections when concrete for this Contract is being mixed, placed, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Make sure that adequate access to the Site to enable hauling, storage, and proper handling of the precast concrete beams has been provided.
 2. Erect adequate barricades, warning lights, and/or signs to safeguard traffic in the immediate area of hoisting and handing operations.

3.02 INSTALLATION

- A. Install precast concrete beams to the lines and grades indicated on the Contract Documents or as otherwise specified.
- B. Set the precast concrete beams in place in accordance with the approved Shop Drawings.
1. Submit the precast concrete beam installation instructions to the Program Manager for information.
- C. Furnish and maintain temporary bracing in place for the precast concrete beams as required for structural stability until final support is provided.



- D. Special Techniques:
 - 1. Field modifications to the precast concrete beams are not allowed unless approved by the Program Manager.
 - 2. Painting:
 - a. Paint the exposed surfaces of the precast concrete U-beams that will not receive additional concrete in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete.
- E. Tolerances:
 - 1. Furnish, erect, and interface the precast concrete members within the tolerances specified for the applicable element type in PCI MNL-135.

3.03 REPAIR / RESTORATION

- A. The repair of damage occurring to the precast concrete beams after installation is the responsibility of the Contractor.
- B. The Contractor is responsible for any chipping, spalling, or other damage to the Work discovered at the Site, unless the damage occurred during storage by others.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when precast concrete is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform testing and inspections.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Cooperate with the Testing and Inspection Agency and code-required Approved Agency to facilitate their testing and inspections.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Special Anchorage Device Acceptance Test:
 - a. Test Procedure:
 - 1) The test will be performed on special anchorage devices as specified in Article 10.3.2.3, Special Anchorage Device Acceptance Test, appearing in Division II, Construction, of the AASHTO Standard Specifications for Highway Bridges.
 - b. Acceptance Criteria:



- 1) Special anchorage devices complying with the criteria specified in Article 10.3.2.3, Special Anchorage Device Acceptance Test, appearing in Division II, Construction, of the AASHTO Standard Specifications for Highway Bridges will be acceptable.
3. Inspections:
 - a. The installation of the prestressed concrete U-beams will be periodically observed to verify the beams are installed in accordance with "Chapter 16 - Precast Concrete" in ACI 318/318R.
- B. Non-Conforming Work
 1. Notify the prestressed concrete U-beam erector of observed discrepancies between the installation of the beams and the installation indicated in the Contract Documents so corrective action can be taken.

3.05 PROTECTION

- A. Immediately after the precast concrete beams are erected, protect the units from damage.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition



SECTION 03435

PRESTRESSED CONCRETE BEAMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for prestressed concrete beams, including providing the precast concrete beams; furnishing, placing, and tensioning prestressing steel in accordance with the details shown on the Contract Drawings.
 - a. Prestress the precast concrete members using the pretensioning method.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 03200 - Reinforcing Steel.
 - 4. Section 03300 - Cast-In-Place Concrete.
 - 5. Section 03410 - Plant-Precast Structural Concrete.

1.02 REFERENCES

- A. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO Standard Specifications for Highway Bridges.
 - b. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing.
 - 1) AASHTO M 194M/M 194 - Standard Specification for Chemical Admixtures for Concrete.
 - 2) AASHTO M 203M/M 203 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement.
 - 3) AASHTO M 204M/M 204 – Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.
 - 4) AASHTO M 275M/M 275 - Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete.
 - 2. American Concrete Institute (ACI):
 - a. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
 - 3. ASTM International (ASTM):
 - a. ASTM A 416/A 416M – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - b. ASTM A 421/A 421M – Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.



- c. ASTM A 722/A 722M – Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
- d. ASTM C 31/C 31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- e. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- f. ASTM C 150 - Standard Specification for Portland Cement.
- g. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- h. ASTM C 494/CA 494M – Standard Specification for Chemical Admixtures for Concrete.
- 4. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.
- B. Precast/Prestressed Concrete Institute (PCI):
 - 1. PCI MNL-135 – Tolerance Manual for Precast and Prestressed Concrete Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure that notification is received by them sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Provide 10 days notification prior to the time the precast concrete units will be available for plant inspection.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Precast concrete unit anchorage.
 - 2) Precast concrete unit lifting inserts.
 - 3) Other Precast concrete unit devices.
 - 4) Precast concrete unit accessory items.
 - b. Shop Drawings:
 - 1) Shop Drawings of the prestressed precast concrete beams.
 - c. Certificates:



- 1) Certificate of Analysis for the Portland cement used in the grout mix.
- 2) Calibration certifications for the jacking system.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Concrete mix designs, and concrete mix design test data.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's handling methods for the products.
 - 2) Installation instructions for the precast concrete units.
 - 3) Installation instructions for precast concrete unit anchorage
 - 4) Installation instructions for precast concrete unit lifting inserts.
 - 5) Installation instructions for other precast concrete unit devices.
 - 6) Installation instructions for precast concrete unit accessory items.
 - c. Site Quality Control Submittals:
 - 1) Force/elongation records of the tensioning process.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.

B. Qualifications:



1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Do not ship precast concrete units if damage impairing the performance of the product could result.
 2. Transport precast concrete units in a manner that will minimize potential damage.
 3. Deliver precast concrete units to the Site in accordance with the approved delivery schedule to avoid excessive build-up of units in the storage area at the Site.
 4. The Inspector will inspect each precast concrete unit as it is delivered to the Site for quality and acceptance.
 5. All prestressing steel, and bar couplers without proper lot numbers found at the Site will be rejected.
- B. Storage and Handling Requirements:
 1. Employ lifting methods and devices intended for the purpose as indicated on the approved Shop Drawings.
 - a. Submit manufacturer's information that shows acceptable handling methods for the products.
 - b. Lift precast concrete units at points provided by the precast concrete manufacturer using suitable lifting devices.
 - c. Consistent with industry standards, furnish lifting devices having a minimum factor of safety of 4.
 - 1) Furnish reusable lifting hardware and rigging having a minimum factor of safety of 5.
 2. Store and handle precast concrete units and materials in a manner that will minimize potential damage.
 - a. Do not place precast concrete units directly on the ground.
 - b. Store Portland cement so it is protected from dampness.
 - 1) Do not use cement which has become partially set or which contains caked lumps.



3. Prohibitions:
 - a. Do not perform any welding near the prestressing steel or ducts unless it is indicated on the Contract Drawings, or directed by the Program/Project Manager.
 - b. Do not locate a welding ground near the prestressing steel or ducts.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. ENVISION Requirements:
 1. Recycled Content
 - a. Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 2. Regional Content
 - a. For each mix design, submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- B. Description:
 1. Prestressed concrete beams consist of precast concrete structural members that have prestressing steel strands embedded in the beams as indicated on the Contract Drawings.
 2. Additional components of the prestressed concrete beams required by the particular prestressing system used include strand deflection devices such as hold-downs and hold-ups for the pretensioning systems.
 3. Precast Concrete beams:
 - a. Have the manufacturer's Professional Engineer perform the following tasks:
 - 1) Determine the concrete mix design proportions.
 - a) Submit a mix design for each strength and type of concrete that will be used.
 - (1) Include the mix's 28-day compressive strength, air content, and slump.
 - (2) Provide the quantity, type, and brand of all mix design constituents in the design, and include applicable Product Data for each constituent.
 - (3) Include copies of supporting concrete mix design test reports showing the mix has successfully produced



concrete with the specified properties, and will be suitable for Contract conditions.

- 2) Prior to releasing the precast concrete beam design for fabrication, have the manufacturer's Professional Engineer prepare, seal, sign, and submit Shop Drawings, design calculations, and manufacturer's installation instructions for the proposed precast concrete beams to the Program/Project Manager for approval.
 - a) Show complete design, installation, and construction information in sufficient detail to enable the Program/Project Manager to determine whether or not the beams conform to the original design intent.
 - b) Indicate the type, size, number, and properties of the strands.
 - c) Indicate the limits of strand debonding.
 - d) Indicate the sizes, shapes, dimensions, placement, and concrete cover of steel reinforcement.
 - (1) Include reinforcing steel required to be relocated or added to existing structures.
 - e) Show the locations and the harping points of the strands, and identify the type of finish or surface condition on the top of the precast beams.
 - f) Indicate the tensioning of the strands.
 - g) Indicate the elongation of the strands at the time of jacking.
 - h) Show precast concrete beam dimensions, connection details, openings, and the erection sequence.
 - i) Include composite scale drawings with plan, elevation, and section views that show the relative positions of all embedded items and their embedment depths for both the prestressed elements and the other Work that is associated with these elements.
 - (1) Embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, reinforcing steel, anchor bolts, earthquake restrainers, deck joint assemblies, drainage systems, utility conduits, and other similar items.
 - j) Include details of supplemental steel that remains as part of finished product.
 - k) Indicate lifting points, devices and loads.
 4. Accessory Items:
 - a. Submit Product Data sheets and proper installation instructions for the accessory items, installed before or after delivery of the precast concrete units, to the Program/Project Manager for approval.
- C. Design Criteria:
1. Precast Concrete:
 - a. Concrete Compressive Strength



- 1) Provide precast concrete units having a 28-day compressive strength (f'_c) as noted on the Contract Drawings.
 - b. Provide the auxiliary and confining reinforcement, minimum edge distance, minimum anchor spacing, and minimum concrete strength at the time of stressing as indicated in the Contract Documents.
 - c. Provide precast concrete units conforming to the unit tolerances specified in PCI MNL-135 for the element, erection, and interfacing.
2. Stresses in the Prestressing Steel:
 - a. Unless otherwise indicated in the Contract Documents, stresses in the prestressing steel may not exceed those specified in the AASHTO Standard Specifications for Highway Bridges.
 - 1) Consider the working force to be the force remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, losses in prestressing steel due to sequence of stressing, friction, and all other losses peculiar to the method or system of prestressing, have taken place or have been provided for.

D. Materials:

1. Portland Cement Concrete:
 - a. Provide Portland cement concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete, for the class indicated in the Contract Documents.
2. Prestressing Steel:
 - a. Provide prestressing steel that complies with the requirements of AASHTO M 204M/M 204.
 - 1) Provide high-tensile steel wire, high-tensile seven-wire strand, or high-tensile alloy bars as indicated on the Contract Drawings.
 - a) High-tensile steel wire:
 - (1) Provide high-tensile steel wire complying with the requirements specified in AASHTO M 204M/M 204 (ASTM A 421/A 421M).
 - b) High -tensile seven-wire strand:
 - (1) Provide high-tensile seven-wire strand complying with the requirements for Grade 270 specified in AASHTO M 203M/M 203 (ASTM A 416/A 416M).
 - c) High -tensile alloy bars:
 - (1) Provide high-tensile alloy bars complying with the requirements specified in AASHTO M 275M/M 275 (ASTM A 416/A 416M).
3. Reinforcing Steel:
 - a. Provide reinforcing steel that complies with the requirements of Section 03200, Reinforcing Steel.
4. Debonding Material (Sheathing):
 - a. Provide debonding material consisting of tubular, non-slit, high-density plastic sheathing with a minimum wall thickness of 0.025 inch, and an



inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch.

- b. Provide debonding material which does not react with concrete, coating, or steel; and will prevent the intrusion of water or cement paste during concrete placement.

E. Shop Fabrication:

1. Jacking Equipment:

- a. Furnish hydraulic jacks equipped with either a pressure gauge or load cell capable of determining the jacking force of the jack.
 - 1) Use either single strand or multiple strand jacks to tension the prestressing steel.
 - 2) Calibrate both the jack and its gauge as a unit, and furnish a certified calibration chart for each unit.
 - a) Submit the latest calibration certifications for the jacking system to the Program/Project Manager with the design calculations for information.
 - b) Calibration certifications for the jacking system older than 6 months are unacceptable.
 - 3) Furnish pressure gauges having either a 6-inch diameter reading dial or a digital display indicator.
 - a) Visibility: Readable by a person with normal vision at a distance of 10 feet.
 - b) Gauge Load Accuracy: Within one percent of the load throughout the entire range of the gauge.
 - c) Reading Dial Increments: No more than 2 percent of the jacking force.
- b. Submit a graph showing the gauge pressure in pounds per square inch and force in thousands of pounds for the jacking system plotted through the entire range of the tensioning calibration.

2. Strand Splicing:

- a. Splicing of strands is permitted, but splicing is not allowed within a member.
- b. Only one splice per strand is allowed.
- c. Strands to be spliced must have the same lay or direction of twist.

3. Stringing Prestressing Steel:

- a. Limit the rotation of each strand to one revolution per 100 feet of exposed strand.
- b. Do not incorporate the lengths of strand having points that have been previously gripped in anchoring devices within the following lengths of strand being strung.

4. Tensioning Prestressing Steel:

- a. At the time of its installation and tensioning, satisfactorily protect the prestressing steel from damage by abrasion, moisture, rust, or corrosion; and make sure the prestressing steel is free of dirt, rust, oil, grease, and other deleterious substances.



- b. Using hydraulic jacks, tension the prestressing steel so that the force in the prestressing steel is not less than the value shown on the Contract Drawings.
 - 1) Conduct the tensioning process so that the force applied to the prestressing steel and the elongation of the prestressing steel will be measured at all times during the process.
 - a) Keep a record of the prestressing force applied and the associated elongations measured during the entire tensioning process.
 - b) Submit the force/elongation records of the tensioning process to the Program/Project Manager for information.
 - 2) Apply the jacking force to the prestressing steel in 2 increments:
 - a) Apply an initial force to the strands to straighten them, eliminate slack, and provide a starting reference point for measuring elongation.
 - b) Then apply the pretensioning force, and measure the elongation.
 - c) Compare the actual elongation measured during application of the calibrated jacking force to the theoretical calculated elongation.
 - (1) If the actual measured elongation differs from the theoretical calculated elongation by more than 5 percent, do not proceed with the tensioning until the tensioning procedure is checked and the source of the error is determined and corrected.
- 5. Precast the concrete for the prestressed concrete beams in accordance with the requirements of Section 03410, Plant-Precast Structural Concrete, except use the materials and additional procedures specified in this Section.
 - a. Do not transfer the tensioning force in the pretensioned strands to the precast member until the concrete strength, determined by performing concrete strength test on concrete specimens made and cured under the same conditions as the precast member, has attained the compressive release strength required.
 - 1) The tests will be performed by the Testing and Inspection Agency and/or the code-required Approved Agency.
 - 2) The transfer of the tensioning force in the pretensioned strands to the precast member is considered the end of the curing period.
 - b. If the concrete has not been placed within 72 hours of the tensioning of the prestressing strands, re-tension the strands prior to placing the concrete.
 - c. If so ordered by the Program/Project Manager, no more than 3 hours prior to placing the concrete for the member those prestressing strands that were individually tensioned may be checked for loss of force.



- 1) Re-tension all strands showing a loss of prestress greater than 3 percent to the original jacking force.
6. Detension the strands following the curing period by releasing the strands from one or both ends of the casting bed depending on which method will produce the least movement of members in the casting bed and the least horizontal eccentricity of the initial prestressing force in the member.
 - a. If the concrete has been heat-cured, detension the strands immediately following the curing period.
7. Cut off all projecting strands that are not scheduled to remain for future embedment.
 - a. Cut and bend the strands scheduled to remain to the dimensions shown on the Contract Drawings.
 - b. If the end of the prestressed concrete beam will not be embedded in cast-in-place concrete, cut all strands or grind them flush with the surface of the concrete; and thoroughly coat them with a bitumastic type sealant.
8. Debonded Strands
 - a. Extend debonding material for debonded prestressing steel through the header.
 - b. Tie and tape the debonding material at the terminus inside the member.
 - c. Within 48 hours of detensioning the steel, seal the openings between the strand and the sheathing for the debonded strands with a 100 percent silicone sealant.
 - d. Do not use strands debonded over the full length of the beam.
9. Clean concrete laitance and other foreign matter from exposed uncoated reinforcing bars and strand.
 - a. If concrete laitance has hardened and other foreign matter remains on the bars, use abrasive blast methods to clean the bars.

F. Finishes:

1. Shop Finishing Methods:
 - a. Finish and patch the precast concrete surfaces as indicated on the Contract Drawings and specified in Section 03300, Cast-In-Place Concrete.
 - 1) After patching surfaces exposed to view, apply a rubbed finish, and use a mortar "lather" matching the color of the surrounding surface to produce a thin film on the surface.
 - 2) Once light dust appears, brush or sack the surface in one direction to produce a uniform texture and color.
 - b. Unless otherwise shown on the Contract Drawings, roughen the top surface of the prestressed concrete beams using a hand tine rake while the concrete is still plastic.



2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. During the period when concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders on the Site for the sole use of the Testing and Inspection Agency and the code-required Approved Agency.
 - c. Provide containers for transporting concrete test cylinders to the testing laboratory.
 - d. The Testing and Inspection Agency and the code-required Approved Agency must perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required by failure of material to meet specified requirements.
 - e. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Concrete Strength Test:
 - a. To evaluate the potential strength and uniformity of the precast concrete, at least 5 strength tests will be performed for each prestressed concrete beam to represent the beam's strength.
 - b. Test Procedure:
 - 1) Composite samples will be secured in accordance with ASTM C 172.
 - a) Representative test samples will be obtained from different batches of concrete on a truly random basis by selecting a test batch number at random before commencing the placement of concrete.
 - b) When pumping or pneumatic equipment is used, samples will be obtained at the truck and discharge ends.
 - c) Sufficient test samples to perform not less than 5 strength tests of two 28-day cylinders per test will be taken for each concrete mix design.
 - (1) Samples for each concrete mix design will be taken not less than once a day, or not less than once for each 100 cubic yards of concrete placed.
 - 2) At least 4 concrete test cylinders will be molded in strict compliance with the requirements of ASTM C 31/C 31M for each



- strength test, and the cylinders will be cured for a 24-hour initial curing period.
- a) A responsible representative from the Quality Assurance Testing and Inspection Agency will make the concrete test cylinders, and immediately thereafter pack them in a sturdy container furnished by the Contractor and approved by the Quality Assurance Testing and Inspection Agency.
 - b) Surround the concrete test cylinders with wet sand or sawdust and protect them from freezing.
 - c) The concrete test cylinders will be sequentially numbered and the number, the date each cylinder was made, and the results of the slump test and the temperature for each sample on the day of sampling will be recorded on the proper form, and the concrete test cylinders will be transported to the testing laboratory where they will be cured in strict compliance with ASTM C 31/C 31M until the time of the test.
- 3) Each strength test will be performed in accordance with ASTM C 39/C 39M as follows:
- a) 2 concrete test cylinders from the same sample will be tested 7 days after the cylinders were made for information.
 - b) 2 additional concrete test cylinders from the same sample will be tested 28 days after the cylinders were made for acceptance.
 - c) The compressive strengths of the two specimen cylinders tested at 28 days will be averaged.
 - d) If one concrete test cylinder in a strength test manifests evidence of improper sampling, molding, or testing, it will be discarded and the strength of the remaining cylinder will be considered to be the test result; if both specimen cylinders in a test for a single sample show any of the above defects, the entire test for that sample will be discarded.
- c. Acceptance Criteria:
- 1) The test results for standard molded and cured test cylinders will be evaluated separately for each prestressed concrete beam by comparing the test results to the minimum requirements for the Class of concrete as specified.
 - 2) The strength level of the concrete will be considered satisfactory so long as the average of all sets of 3 consecutive compressive strength test results equal or exceed the specified strength f'_c , and no individual strength test result falls below the specified strength f'_c by more than 500 psi.
3. Inspections:
- a. Record and submit force/elongation records of the tensioning process to the Program Manager for information.



- b. The Program/Project Manager may verify the accuracy of the certified calibration charts for the jacking equipment using its own load cells.
 - 1) If the certified calibration for the jacking equipment is found to be in error, immediately discontinue tensioning operations being performed by that equipment until a new certified calibration chart is produced.
- B. Non-Conforming Work:
 - 1. Repairing Minor Defects:
 - a. Products having defects that will not impair the functional use or expected life of a precast concrete beam may be repaired by any method that does not impair the product.
 - 2. Repairing Honeycombed Areas:
 - a. Where honeycombed areas are to be repaired, remove all loose material and cut back the areas to essentially horizontal or vertical planes.
 - 1) Cut back the areas to a depth where at which coarse aggregate particles break under chipping rather than being dislodged.
 - b. Use proprietary repair materials in accordance with the manufacturer's instructions to fill the depression.
 - c. If proprietary repair materials are not used, saturate the area with water immediately prior to starting the repair.
 - 1) Make sure the repair area is damp, but free of excessive water.
 - 2) Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.
 - 3. Repairing Major Defects:
 - a. Have qualified personnel evaluate defects in precast concrete products which impair the functional use or the expected life of the products to determine if repairs are feasible, and if so, to establish the repair procedure.
- C. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when concrete for this Contract is being mixed, placed, and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:



1. Make sure that adequate access to the Site to enable hauling, storage, and proper handling of the precast concrete beams has been provided.
2. Erect adequate barricades, warning lights, and/or signs to safeguard traffic in the immediate area of hoisting and handing operations.

3.02 INSTALLATION

- A. Install precast concrete beams to the lines and grades indicated on the Contract Documents or as otherwise specified.
- B. Set the precast concrete beams in place in accordance with the approved Shop Drawings.
 1. Submit the precast concrete beam installation instructions to the Program/Project Manager for information.
- C. Furnish and maintain temporary bracing in place for the precast concrete beams as required for structural stability until final support is provided.
- D. Special Techniques:
 1. Field modifications to the precast concrete beams are not allowed unless approved by the Program/Project Manager.
 2. Painting:
 - a. Paint the exposed surfaces of the precast concrete beams that will not receive additional concrete in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete as indicated on the plans.
- E. Tolerances:
 1. Furnish, erect, and interface the precast concrete members within the tolerances specified for the applicable element type in PCI MNL-135.

3.03 REPAIR / RESTORATION

- A. The repair of damage occurring to the precast concrete beams after installation is the responsibility of the Contractor.
- B. The Contractor is responsible for any chipping, spalling, or other damage to the Work discovered at the Site, unless the damage occurred during storage by others.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when precast concrete is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform testing and inspections.



- a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Cooperate with the Testing and Inspection Agency and code-required Approved Agency to facilitate their testing and inspections.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Inspections:
- a. The installation of the prestressed concrete beams will be periodically observed to verify the beams are installed in accordance with "Chapter 16 - Precast Concrete" in ACI 318/318R.
- B. Non-Conforming Work
1. Notify the prestressed concrete beam erector of observed discrepancies between the installation of the beams and the installation indicated in the Contract Documents so corrective action can be taken.

3.05 PROTECTION

- A. Immediately after the precast concrete beams are erected, protect the units from damage.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	11/03/2017	N/A	All	First Edition.





SECTION 03600

GROUTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the grouts, except for masonry grouts, indicated on the Contract Drawings and required in other Specification Sections.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCE STANDARDS:

- A. American Concrete Institute (ACI):
 - 1. ACI 305R, Hot Weather Concreting.
 - 2. ACI 306R, Cold Weather Concreting.
 - 3. ACI 306.1, Standard Specification for Cold Weather Concreting.
 - 4. ACI 308, Standard Specification for Curing Concrete.
 - 5. ACI 351.1R, Grouting between Foundations and Bases for Support of Equipment and Machinery.
- B. ASTM International (ASTM):
 - 1. ASTM C 33, Standard Specification for Concrete Aggregate.
 - 2. ASTM C 109/C 109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two-inch or 50-mm Cube Specimens).
 - 3. ASTM C 150, Standard Specification for Portland Cement.
 - 4. ASTM C 191, Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
 - 5. ASTM C 827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
 - 6. ASTM C 1090, Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
 - 7. ASTM C 1107, Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).

1.03 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Non-shrink metallic grout.
 - 2) Non-shrink non-metallic grout.
 - b. Certificates:
 - 1) Grout manufacturer non-shrink certification.
- B. Informational Submittals:
 1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's placing instructions.

1.04 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- B. Qualifications:
 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
 2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
- C. Certifications:
 1. Submit independent laboratory test reports from the grout manufacturers certifying the non-shrink grout meets the performance requirements specified in Article 2.01.



1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. During delivery, provide a protective covering over grout materials to prevent moisture damage and contamination.
- B. Storage and Handling Requirements:
 - 1. During handling, provide a protective covering over grout materials to prevent moisture damage and contamination.
 - 2. Store and precondition grout and grout materials in accordance with the grout manufacturer's requirements.
 - a. Provide air conditioned storage if required.
 - 3. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.06 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Protect grout against high and low temperatures and unfavorable environmental conditions in accordance with the requirements of ACI 305R, ACI 306R, and ACI 306.1 for placement of concrete until it has cured.

PART 2 PRODUCTS

2.01 PERFORMANCE:

- A. Non-Shrink Grout:
 - 1. Provide non-shrink grout that meets the following requirements from the time of placement:
 - a. Early Height Change: 0.0 to 4.0 percent when tested in accordance with the requirements of ASTM C 827.
 - b. Hardened Height Change: 0.0 to 0.3 percent when tested in accordance with the requirements of ASTM C 1090.
 - c. Compressive Strength: 4,000 psi developed with a trowelable mix within 24 hours when tested in accordance with the requirements of ASTM C 109/C 109M modified in accordance with the requirements of ASTM C 1107.
 - d. Indicating placement time: Not less than 60 minutes based on initial set, when tested in accordance with the requirements of ASTM C 191.
 - 2. Provide grout that meets the performance requirements of ASTM C 1107 for Grades A, B, and C.

2.02 MATERIALS:

- A. Aggregate:



1. Fine Aggregate: Provide fine aggregate conforming to the material quality requirements of ASTM C 33.
- B. Non-Shrink Metallic Grout:
 1. Provide a factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums.
 - a. Provide a ready-mix type of grout requiring only the addition of water.
 - 1) Provide water proportions conforming to the manufacturer's specifications for the desired mix consistency.
 - b. Do not add other materials to the grout.
 - c. Provide grout manufactured using cement complying with the requirements for Type I (Normal) cement as specified in ASTM C 150.
 - d. To enhance impact resistance, provide grout containing metallic aggregate.
 2. Acceptable Manufacturers:
 - a. Five Star Products, Inc., www.fivestarproducts.com.
 - b. US Grout, LLC., www.usgrout.com.
 - c. Approved equal.
- C. Non-Shrink Non-Metallic Grout:
 1. Provide a factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums.
 - a. Provide a ready-mix type of grout requiring only the addition of water.
 - 1) Provide water proportions conforming to the manufacturer's specifications for the desired mix consistency.
 - b. Do not add other materials to the grout.
 - c. For grout applications not in contact with sewage or soils, provide grout manufactured using cement complying with the requirements for Type I (Normal) cement as specified in ASTM C 150.
 - d. For grout applications in contact with sewage or soils, provide grout manufactured using complying with the requirements for Type II (sulfate resistant) cement as specified in ASTM C 150.
 2. Acceptable Manufacturers:
 - a. Five Star Products, Inc., www.fivestarproducts.com.
 - b. US Grout, LLC., www.usgrout.com.
 - c. BASF Construction Chemicals - Building Systems, www.buildingsystems.basf.com.
 - d. The Euclid Chemical Company, www.euclidchemical.com.
 - e. Approved equal.
- D. Portland Cement:
 1. Provide Portland cement conforming to the requirements for Type II as specified in ASTM C 150.
 - a. For applications where the grout will be in contact with sewage, use only Type II (sulfate resistant) cement.



E. Water:

1. Provide potable quality water that is free from deleterious amounts of acids, alkalis, and organic substances.

2.03 MIXES:

A. Neat Cement:

1. Use Type II Portland cement and water in the same proportions specified in Section 03300 for Class AA cast-in-place concrete, but omit the fine and coarse aggregates from the mix.

PART 3 EXECUTION

3.01 EVALUATION AND ASSESSMENT

- A. Submit the grout manufacturer's descriptive product data and current specifications covering the non-shrink metallic grout and non-shrink non-metallic grout products to the Program/Project Manager for approval.
- B. Submit the grout manufacturer's placing instructions to the Program/Project Manager for approval.

3.02 PREPARATION

- A. Surface Preparation:
 1. Clean the surfaces to be grouted to a condition free of oil, grease, laitance, dirt, and other contaminants.
 2. Remove loose material.
 3. Remove rust, paint, and oil from metal components that will be in contact with grout.
 4. Perform additional surface preparation in accordance with the grout manufacturer's instructions.

3.03 INSTALLATION

- A. Formwork:
 1. Use forming procedures that allow proper and complete placement of the grout.
 2. Pre-treat wood forms with forming oils so the forms do not absorb moisture, or as approved by the grout manufacturer.
 3. Anchor formwork support elements so no movement is possible.
 4. Remove formwork supports only after the grout has hardened.
- B. Mixing the Grout:
 1. Use a power operated mechanical mixer of sufficient capacity to mix complete batches of grout without interruption.



2. Mix non-shrink grout in accordance with manufacturer's published instructions.
- C. Non-Shrink Metallic Grout:
 1. Place non-shrink metallic grout in exposed or unexposed areas where grouting or equipment is subject to heavy vibratory forces.
 2. Place non-shrink metallic grout in accordance with the manufacturer's published instructions.
- D. Non-Shrink Non-Metallic Grout:
 1. Place non-shrink non-metallic grout only at locations indicated on the Contract Drawings.
 2. Place non-shrink non-metallic grout in accordance with the manufacturer's published instructions.
- E. Equipment and Machinery Support:
 1. To support installed equipment and machinery, place non-shrink grout between the foundations of the supporting structures and the equipment and machinery bases in accordance with the requirements of ACI 351.1R.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when grout is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of grout test samples on the Work Site for the sole use of the Testing and Inspection Agency and the code-required Approved Agency.
 - c. Provide containers for transporting grout test samples to the testing laboratory.
 - d. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - e. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Compressive Strength Test:



- a. Test Procedure:
 - 1) A test sample will be obtained from the first placement of the day, and for every 3 cubic yards of grout placed each day.
 - 2) The grout will be tested in accordance with the requirements of ASTM C 109/C 109M modified in accordance with the requirements of ASTM C 1107.
 - b. Acceptance Criteria:
 - 1) Grout meeting the requirements specified in Subparagraph 2.01.A.1.c will be acceptable.
 - 3. Inspections:
 - a. All grout placement will be visibly inspected to verify if proper placement procedures are being followed.
- B. Non-Conforming Work
- 1. Remove under-strength grout, and replace the removed grout with grout meeting the specified requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 03601

POLYESTER CONCRETE OVERLAY

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. This work includes placing a polyester concrete overlay with a high molecular weight methacrylate (HMWM) resin prime coat for exterior walkways.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data: Polyester Concrete
 - b. Overlay Placement Plan
 - 1) Schedule of overlay work and testing for each bridge
 - 2) Description of equipment for applying HMWM resin
 - 3) Description of equipment for measuring, mixing, placing, and finishing polyester concrete overlay
 - 4) Method for isolating expansion joints
 - 5) Cure time for polyester concrete
 - 6) Description of equipment for applying sand
 - 7) Storage and handling of HMWM resin and polyester concrete components
 - 8) Disposal of excess HMWM resin, polyester concrete, and containers
 - c. Public Safety Plan to include:
 - 1) An airborne emissions monitoring plan prepared and executed by a certified industrial hygienist (CIH) certified in comprehensive practice by the American Board of Industrial Hygiene. The plan must have at least 4 monitoring points including the mixing point, application point, and point of nearest public contact. Monitor airborne emissions during overlay work and submit emissions monitoring results after completing the work.



- 2) An action plan for protection of the public when airborne emissions levels exceed permissible levels.
- 3) A copy of the CIH's certification.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's mixing and placing instructions.

1.03 QUALITY ASSURANCE

A. Trial Overlay: Complete a trial overlay before starting work. Results from airborne emissions monitoring of the trial overlay must be submitted to the Construction Manager before starting production work. The trial overlay must:

1. Be at least 8 feet wide by 4 feet long, $\frac{3}{4}$ inch thickness, incorporate the colors shown on the plans
2. Be constructed on a prepared concrete base
3. Be placed within the project limits at an approved location
4. Be constructed using the same equipment as the production work
5. Replicate field conditions for the production work
6. Determine the initial polyester concrete set time
7. Demonstrate suitability of the proposed means and methods
8. Demonstrate suitability of the airborne emissions monitoring plan
9. Illustrate minimum finish requirements per code and as stated in drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Polyester polymer concrete physical properties

1. Density: 135 lb/cu ft
2. Compressive Strength: 7000 psi
3. Tensile Strength: 800 psi

B. Polyester Resin Binder Must:

1. Be an unsaturated isophthalic polyester-styrene co-polymer.
2. Contain at least 1 percent by weight gamma-methacryloxypropyltrimethoxysilane, an organosilane ester silane coupler.
3. Be used with a promoter compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.



4. Comply with the following:

Polyester Resin Binder

Property	Requirement	Test Method
Viscosity *	0.075 to 0.200 Pa·s (RVT, No. 1 Spindle, 20 RPM at 77°F)	ASTM D 2196
Specific Gravity *	1.05 to 1.10 at 25°C	ASTM D 1475
Elongation	35 percent, minimum Type I at 11.5 mm/min. Thickness = 6.5±1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
Tensile Strength	17.5 MPa, minimum Type I at 11.5 mm/min. Thickness = 6.5±1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
Styrene Content *	40 percent to 50 percent by weight	ASTM D 2369
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum, at 24 hours and 21° ± 1°C	California Test 551
Static Volatile Emission *	60 gram per square meter, loss, maximum	SCAQMD Method 309-91

*Test must be performed before adding initiator.

C. Aggregate for polyester concrete must:

1. Have at most 45 percent crushed particles retained on the 2.36-mm sieve.
2. Have fine aggregate consisting of natural sand.
3. Have a weighted average aggregate absorption of at most 1 percent.
4. At the time of mixing with resin, have a moisture content of at most one half of the weighted average aggregate absorption.
5. Comply with one of the following aggregate gradings:

Combined Aggregate Grading

Sieve Size	Percentage Passing	
	3/8 inch Maximum	No. 4 Maximum
12.5-mm	100	100
9.5-mm	83 - 100	100
4.75-mm	65 - 82	62 - 85
2.36-mm	45 - 64	45 - 67
1.18-mm	27 - 48	29 - 50
600-µm	12 - 30	16 - 36
300-µm	6 - 17	5 - 20
150-µm	0 - 7	0 - 7
75-µm	0 - 3	0 - 3



- D. HMWM resin prime coat consists of a resin, promoter, and initiator. HMWM resin must:

1. Be low odor and wax-free
2. Comply with the following:

Methacrylate Resin		
Property	Requirement	Test Method
Volatile Content *	30 percent, maximum	ASTM D 2369
Viscosity *	0.025 Pa·s, maximum, (Brookfield RVT with UL adaptor, 50 RPM at 25°C)	ASTM D 2196
Specific Gravity *	0.90 minimum, at 25°C	ASTM D 1475
Flash Point *	180°F, minimum	ASTM D 3278
Vapor Pressure *	1.0 mm Hg, maximum, at 25°C	ASTM D 323
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum at 24 hours and 21 ± 1°C	California Test 551

* Test must be performed before adding initiator.

- E. Finish quality shall meet the following:
1. Texture: Medium broom finish
 - a. Meet or exceed wet and dry coefficient of friction code requirements for walking surfaces
 2. Color: Two colors shown on drawings. Architect to select custom colors.
 3. Flake Color Chips: Mica flakes
 - a. Color: Black
 - b. Size: Standard 1/4"
 - c. Broadcast Option: Light sprinkle

PART 3 EXECUTION

3.01 EVALUATION AND ASSESSMENT

- A. Submit the polyester concrete manufacturer's descriptive product data and current specifications covering products to the Program/Project Manager for approval.
- B. Submit the polyester concrete manufacturer's placing instructions to the Program/Project Manager for approval.



3.02 PREPARATION

- A. Surface Preparation: Thoroughly clean surface area to receive HMWM prime coat, final clean and dry with compressed air. Follow all preparation instructions per manufacturer's recommendations

3.03 INSTALLATION

- A. HMWM Prime Coat: Thoroughly mix all components of HMWM resin prime coat. Apply the HMWM resin to the deck surface:
1. Clean the surfaces to be grouted to a condition free of oil, grease, laitance, dirt, and other contaminants.
 2. Remove loose material.
 3. Remove rust, paint, and oil from metal components that will be in contact with grout.
 4. Perform additional surface preparation in accordance with the grout manufacturer's instructions.
- B. Polyester Concrete Mixing:
1. Use a continuous mixer that:
 - a. Employ an auger screw/chute device.
 - b. Be equipped with an automatic metering device that measures and records aggregate and resin volumes. Record volumes at least every 5 minutes, including time and date. Submit recorded volumes at the end of the work shift.
 - c. Have a visible readout gage that displays volumes of aggregate and resin being recorded.Produce a satisfactory mix consistently during a demonstration.
- C. Polyester Concrete Placement:
1. Immediately after applying the HMWM prime coat
 2. Before gelling
 3. Within 15 minutes of adding initiator
 4. Consolidate and finish the overlay to the required grade and cross section using finishing equipment.
 5. Finish the surface per plans
 - a. Broadcast mica flakes onto concrete surface to achieve the finish quality aesthetically.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	09/19/2018	BUL-0025	All	First edition.





SECTION 03935

FIBER-REINFORCED POLYMER CONCRETE REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for designing and providing a bonded carbon fiber reinforced polymer (CFRP) system to strengthen deteriorated concrete and structurally engineered modified concrete structures.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01500 - Temporary Facilities and Controls.
 - 4. Section 01736 - Selective Demolition.
 - 5. Section 03920 – Concrete Resurfacing.
 - 6. Section 07810 – Applied Fireproofing.
 - 7. Section 09967 – Intumescent Paints.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CFRP-Carbon fiber reinforced polymer.
 - 2. MSDS: Material Safety Data Sheets.
 - 3. NRTL – Nationally Recognized Testing Laboratory.
 - 4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Concrete Institute (ACI):
 - a. ACI 224.1R – Causes, Evaluation, and Repair of Cracks in Concrete Structures.
 - b. ACI 440.2R - Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures.
 - c. ACI 440R – Report on Fiber-Reinforced Polymer (FRP) Reinforcement of Concrete Structures.



- d. ACI 503.1 – Standard Specifications for Bonding Hardened Concrete, Steel, Wood, Brick and Other Materials to Hardened Concrete with a Multi-Component Epoxy Adhesive.
- e. ACI 503.4 - Standard Specifications for Repairing Concrete with Epoxy Mortars.
- f. ACI 503.5R – Guide for the Selection of Polymer Adhesives in Concrete.
- g. ACI 503.7 – Specification for Crack Repair by Epoxy Injection
- h. ACI 546R - Concrete Repair Guide.
- i. Concrete Repair Manual, 3rd Edition, 2008; Volume 1 and 2.
- 2. ASTM International (ASTM):
 - a. ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
 - b. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
 - c. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
 - d. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - e. ASTM D 2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
 - f. ASTM D 3039/D 3039M - Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials.
 - g. ASTM D4541 Standard Test Method for Pull-off Strength of Coatings using portable Adhesion Testers.
 - h. ASTM D 5687/D 5687M - Standard Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation.
 - i. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - j. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. ICC Evaluation Service, Inc. (ICC-ES):
 - a. ICC-ES AC125 – Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems.
 - b. ICC-ES AC178 - Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-Reinforced Polymer (FRP) Composite Systems.
 - c. ICC-ES AC85 – Acceptance Criteria For Test Reports.



6. International Concrete Repair Institute (ICRI):
 - a. ICRI 210.3 – Technical Guideline for Using In-Situ Tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials.
 - b. ICRI 310.1R – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
 - c. ICRI 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 - d. ICRI 320.2R - Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- B. Pre-Installation Meetings:
 1. Prior to application of the bonded carbon fiber reinforced polymer (CFRP) system, convene an onsite meeting to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
 2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of CFRP system elements, shoring and bracing Subcontractor, the demolition Subcontractor, the concrete resurfacing Subcontractor, and the fire proofing Subcontractor.
- C. Sequencing:
 1. Clean, prepare, and patch concrete to receive the bonded carbon fiber reinforced polymer (CFRP) system prior to applying this concrete rehabilitation system.
- D. Scheduling:
 1. Prior to beginning installation of the bonded carbon fiber reinforced polymer (CFRP) system, prepare a detailed CFRP Schedule describing the work to be accomplished.
 - a. Submit the CFRP Schedule to the Program/Project Manager for approval.

1.04 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Carbon fiber reinforced polymer (CFRP) concrete rehabilitation system.
 - 2) Provide an ICC Evaluation Service Report, compliant with the 2012 IBC, for the proposed products.
 - 3) Provide approved UL rated assembly data for a min 3-hour fire rated assembly per ASTM E119.
 - 4) Properties of the composite materials as determined by independent laboratory testing in accordance with ASTM D7565 and/or ASTM D3039 (tensile modulus, stress and strain).
 - b. Shop Drawings:
 - 1) Proposed concrete rehabilitation material design.
 - 2) Working drawings shall detail the type, locations, dimensions, numbers of layers, and orientation of all FRP materials and coatings to be installed.
 - c. Delegated Design Submittals:
 - 1) Design calculations for the proposed concrete rehabilitation material design.
 - 2) List calling out Special Inspection Requirements that will be required by the Designer, the Manufacturer and any Building Code Requirements.
 - 3) List of special test requirements and acceptable range of values to be used when applying In-Situ Tensile Pull-Off Test (ICRI Technical Guideline No. 210.3-2004) to evaluate existing concrete surface before application of CRFP system and after CRFP system has been installed prior to application of fire resistance materials.
 - 4) Quality Control Manual
 - 5) Design Manual
 - d. Special Procedure Submittals:
 - 1) CFRP Schedule.
 - e. Qualification Statements:
 - 1) Carbon fiber reinforced polymer (CFRP) system installer's qualifications.
 - 2) Testing Agency's qualifications.
 - 3) Professional Engineer's qualifications.
 - 4) Certifications of the applicators.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Manufacturer's Instructions:
 - 1) Carbon fiber reinforced polymer (CFRP) system manufacturer's application recommendations.
 - b. Source Quality Control Submittals:
 - 1) Product Test Reports.
 - c. Site Quality Control Submittals:
 - 1) Concrete Rehabilitation Reports
 - d. Manufacturer's Reports:
 - 1) Manufacturer/Suppliers Material Safety Data Sheets (MSDS).
- C. Alternate systems
- 1. Design alternate composite systems to achieve a similar performance to the system shown on the structural drawings. Design calculations for an alternate composite system shall be submitted for approval by the engineer of record, and shall be stamped by a registered Civil or Structural Engineer. Equivalence will be based on stiffness ($E_f \times A_f$). The design modulus (E_f) and associated cross sectional area (A_f) of the FRP system shall be based on published design values consistent with long term durability testing

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2) To perform the Required Inspection per ICC-ES AC178 and furnish Required Documentation per ICC-ES AC178.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
 - b. To perform Testing Requirements per ICC-AC178 and provide Testing Reports per ICC-ES AC85.
- B. Qualifications:



1. Carbon Fiber Reinforced Polymer (CFRP) System Installer's Qualifications:
 - a. Employ a carbon fiber reinforced polymer (CFRP) system installer, certified by the CFRP system manufacturer/supplier to install the CFRP system required by this Contract, and having a successful performance record installing similar CFRP systems.
 - b. Employ a CFRP system installer whose superintendent and assistant have a minimum of 3 years' experience installing similar CFRP systems.
 - c. Submit the carbon fiber reinforced polymer (CFRP) system installer's qualifications to the Program/Project Manager for approval.
2. Professional Engineer's Qualifications:
 - a. Employ an independent Professional Engineer, registered in the State of Arizona, who is qualified to perform calculations and design work required under this Section.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials to the Site in original unopened containers or bundles with labels indicating the manufacturer, product name and designation, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Storage and Handling Requirements:
 1. Store and handle materials in compliance with the manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
 - a. Store materials so they do not contact soil and moisture.
 - b. Store materials so they are not exposed to ultraviolet radiation.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Project Repair work is inside an occupied air-conditioned, smoke controlled building. Work hours will be controlled and limited to late night time hours.
- B. Ambient Conditions:
 1. The relative humidity at the time of installation must be less than 95 percent, the surface temperature must be greater than 5 degrees



Fahrenheit above the dew point, and the concrete must fall between minimum and maximum application temperatures.

- a. If adverse environmental conditions are expected to persist long term, then provide environmental control methods.

PART 2 PRODUCTS

2.01 CARBON FIBER REINFORCED POLYMER (CFRP) SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Fyfe-Aegion Company
- b. Sika Corporation
- c. Approved equal.

2. Substitution Limitations:

- a. The material items herein are manufactured and supplied by Sika Corporation, and establish the minimum standard of quality required for this Contract (ICBO/ICC E.S.R.3288 REPORT).
- b. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from other manufacturers may be provided.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

C. Performance:

1. Provide a bonded carbon fiber reinforced polymer (CFRP) system capable of withstanding the load requirements indicated without failure, based on testing the manufacturer's standard products similar to those specified for this Contract.

2. Fire-Test-Response Characteristics:

- a. Provide concrete rehabilitation materials that have the fire-test-response characteristics specified as determined when Underwriters Laboratories, Inc. (UL) or another testing and inspecting agency acceptable to the Authorities Having Jurisdiction tests identical products in accordance with the following test methods:
 - 1) Fire-Resistance Ratings for Exterior Open Building Structures:
 - a) Provide fire-resistance ratings of 3 hours when tested in accordance with the requirements specified in ASTM E 119.



- b) The fire-resistance system shall have Class 1 flame and smoke rating as defined in the IBC, per ASTM E84 testing performed by Underwriters Laboratories.
 - 2) Fire-Resistance Ratings for Interior Closed Building Structures:
 - a) Provide fire-resistance ratings of 3 hours when tested in accordance with the requirements specified in ASTM E 119
 - b) The fire-resistance system shall have Class 1 flame and smoke rating as per ASTM E84 testing per Underwriters Laboratories.
 - b. Identify materials with appropriate markings of the applicable testing and inspecting agency.
- D. Design Criteria:
 - 1. Design the concrete rehabilitation system in accordance with the requirements specified in ACI 440R, ACI 440.2R, ACI 503.1, ACI 503.5R, and ACI 546R.
 - 2. Provide compatible primer, fillers, and other materials as required for the proper installation of a complete surface bonded fiber reinforced polymer (FRP) composite system as recommended by the manufacturer, complying with the finish requirements indicated for the application in the Contract Documents, and meeting the requirements for the fire rated assembly specified for the application.
 - 3. Product Data:
 - a. Submit a complete list of the materials, products, and special conditions and procedures proposed for the carbon fiber reinforced polymer (CFRP) concrete rehabilitation and fireproofing systems to the Program/Project Manager for approval, including the following:
 - 1) Manufacturer/Supplier's technical data sheets, including physical, mechanical, and chemical characteristics of the materials, for the products to be used in the CFRP composite system.
 - 2) Manufacturer/Suppliers Material Safety Data Sheets (MSDS) for the products to be used in the CFRP concrete rehabilitation system.
 - 3) Clearly defined time application limits for the primer, tack coat, and saturating resin relative to the temperatures of the base material and ambient air.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings for the proposed concrete rehabilitation and fireproofing design, including a complete list of materials, products, and plans and details showing special conditions, lap splices, end offset conditions, fire proofing details, and other details.
 - b. Submit the Shop Drawings of the proposed concrete rehabilitation material design, signed and sealed by a Professional Engineer, to the Program/Project Manager for approval.
 - 5. Calculations:



- a. Prepare design calculations for the proposed concrete rehabilitation material design.
- b. Submit the calculations for the proposed concrete rehabilitation material design, signed and sealed by a Professional Engineer, to the Program/Project Manager for approval.

E. Materials:

1. Approved: SikaWrap Hex 103C Carbon fiber fabric). Products include:
 - a. Carbon fiber:
 - 1) Hex 103C fiber – High strength carbon fiber, unidirectional.
 - b. Epoxy: Sikadur 300 Hex 300 epoxy is used as a primer and is also combined with the fiber to form the SikaWrap® System.
 - c. Fire Resistant Finishes: Sikacrete-213F fire protection mortar for applicable fire resistant finish (if required). Alternate finishes must be approved by the owner.
 - d. Field thickened epoxy matrix, which is compatible with composite system's resin matrix, may be used to patch "bugholes" up to 1.5" in depth and to fill voids.
2. Epoxies other than the pre-qualified materials above can be evaluated prior to the tender closing; materials meeting the requirements will be allowed by written addendum.
3. The manufacturer shall provide specific information on physical, mechanical and chemical properties of fiber, epoxy resin and FRP composite.
4. Carbon Fabric:
 - a. Provide unidirectional SikaWrap Hex 103C carbon fabric having a minimum tensile strength of 550 KSI as a cured laminate using Sika Hex 300 epoxy when determined in accordance with the methods specified in ASTM D 3039/D 3039M.
 - 1) Minimum Composite Laminate Thickness: 0.040 inch.
5. Primer:
 - a. Provide Sikadur Hex 300 a low viscosity, two-component epoxy primer as required by the Manufacturer having 100 percent solids, 0 percent volatile organic content (VOC), and the following properties:
 - 1) Minimum Compressive Strength: 10,000 psi when determined in accordance with the methods specified in ASTM D 695.
 - 2) Minimum Flexural Strength: 13,000 psi when determined in accordance with the methods specified in ASTM D 790.
 - 3) Minimum Tensile Strength: 7000 psi when determined in accordance with the methods specified in ASTM ASTM D 638.
6. Tack Coat:
 - a. Provide Sikadur Hex 300 a low viscosity, two-component epoxy tack coat as required by the Manufacturer having 100 percent solids, 0 percent volatile organic content (VOC), and the following properties:



- 1) Minimum Compressive Strength: 7500 psi when determined in accordance with the methods specified in ASTM D 695.
 - 2) Minimum Flexural Strength: 10,000 psi when determined in accordance with the methods specified in ASTM D 790.
 - 3) Minimum Tensile Strength: 5000 psi when determined in accordance with the methods specified in ASTM D 638.
7. Saturating Resin:
- a. Provide Sikadur Hex 300 a low viscosity, two-component epoxy saturating resin as required by the Manufacturer having 100 percent solids, 0 percent volatile organic content (VOC), and the following properties:
 - 1) Minimum Tensile Strength: 8000 psi when determined in accordance with the methods specified in ASTM D 638.

2.02 SOURCE QUALITY CONTROL

- A. Manufacturer Services:
1. Have the manufacturer perform comprehensive tests, witnessed by the Testing Agency, of the current bonded carbon fiber reinforced polymer (CFRP) system in accordance with the methods specified in ASTM D 3039/D 3039M to determine the properties of the system.
 2. Product Test Reports:
 - a. Based on evaluation of the tests performed by the manufacturer, have the Testing Agency submit certified product test reports that indicate compliance of the bonded carbon fiber reinforced polymer (CFRP) system with the specified requirements.
- B. Coordination of Other Tests and Inspections:
1. Notify the code-required Approved Agency responsible for performing special inspections when the carbon fiber reinforced polymer (CFRP) system for this Contract is being mixed, applied, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. With the carbon fiber reinforced polymer (CFRP) system installer present, examine the concrete, areas, and conditions under which the structural CFRP systems will be applied for compliance with requirements.
 - a. Verify the concrete area is visibly dry and free of moisture.
 2. Examine the existing conditions to identify potential obstructions and constraints.



B. Evaluation and Assessment:

1. When substrate that is defective or unsuitable for installation of the carbon fiber reinforced polymer (CFRP) system is discovered, immediately consult with Program/Project Manager to receive direction.
2. Correct unsatisfactory conditions before proceeding to install the CFRP system.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the carbon fiber reinforced polymer (CFRP) system.

B. Surface Preparation:

1. Clean, prepare, and patch concrete according to the carbon fiber reinforced polymer (CFRP) system manufacturer's written instructions.
 - a. Prepare concrete that is to receive the CFRP in accordance with the requirements specified in ACI 440R, ACI 440.2R, ICRI 310.1R, and ICRI 310.2.
 - b. Test Surface preparation before application of CFRP system per Manufacturer's requirements using ICRI Guideline No.210.3 -2004 for In-Situ Tensile Pull-Off Tests to evaluate Bond surface of existing concrete.
 - c. Repair cracks and voids per Manufacturer's and Designers requirements either by pressure-injecting an epoxy material in these spaces or by applying a thickened epoxy in accordance with the requirements specified in ACI 224.1R, ACI 503.4, ACI 503.7 and ICRI 320.2R.
 - d. Provide a clean, dust-free, and dry substrate for application of the CFRP system.
 - e. Fill uneven surfaces or recesses with thickened epoxy.

C. Demolition / Removal:

1. Remove protrusions that will interfere with the installation of the carbon fiber reinforced polymer (CFRP) system.
2. Remove existing paint from existing concrete surface that will interfere with the installation and bonding of the carbon fiber reinforced polymer (CFRP) system or its fire resistance protection system.
3. Round off chamfered corners and sharp edges that will interfere with the installation of the carbon fiber reinforced polymer (CFRP) system to have a minimum radius of 1/2 inch.

3.03 APPLICATION

- A. Employ a trained field supervisor to observe all aspects of onsite preparation and material application, including surface preparation, mixing the resin



component, application of the primer, fabric epoxy-saturation, application of the fiber layer, curing of the composites and providing fire-resistance system along with any additional requirements of the Manufacturer's/Designer's furnished Quality Control Manual.

- B. Apply the carbon fiber reinforced polymer (CFRP) system in accordance with the manufacturer's recommendations.
 - 1. Mix the epoxy according to the manufacturer's application instructions.
 - 2. Do not use mixed epoxy that has exceeded its pot life.
 - 3. Submit the carbon fiber reinforced polymer (CFRP) system manufacturer's application recommendations to the Program/Project Manager for information.
- C. Adhere the carbon fabric to the concrete surface as recommended by the manufacturer, and roll out all bubbles and voids between the fabric and the panel.
 - 1. Feather the edges and seams.
- D. Finishing:
 - 1. If the epoxy cures between 24 and 72 hours after the final application of the concrete rehabilitation system, finish the system as specified.
 - 2. If the epoxy cures after 72 hours, roughen the surface of the concrete rehabilitation by hand sanding or brush blasting prior to finishing the system.

3.04 REPAIR/RESTORATION

- A. At the locations where test samples that failed the site tests and inspections specified in Article 3.05 have been taken, take remedial measures to ensure the integrity of the system at those locations.
 - 1. In areas where the site tests have determined insufficient material, take remedial measures.
 - 2. If site tests have determined the material applied to a structural member has material properties below the specified minimum values, install additional layers of the carbon fiber reinforced polymer (CFRP) system until the composite thickness is increased by the same percentage as the deficiency of the material's tensile modulus, or provide other remedial measures as directed by the Program/Project Manager
- B. Inject or back fill small voids and bubbles that are on the order of 3 inches (75mm) in diameter with epoxy.
- C. Report voids and delaminations on the order of 6 inches (150mm) in diameter and areas on the order of 5 inches by 5 inches to the Program/Project Manager.



1. Submit proposed remedial measures to the Program/Project Manager for approval prior to implementing them.
- D. Repair damage to the new or existing structures caused by installing or testing the concrete remediation system at no increase in Contract Price.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when carbon fiber reinforced polymer (CFRP) system is being applied, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Fiber-Reinforced Polymer Concrete Rehabilitation Test:
 - a. Test Procedure:
 - 1) Each day that the concrete rehabilitation material is applied, obtain a minimum of two test samples, each consisting of two 12-inch by 12-inch (300mm by 300mm) swatches of cured composite.
 - a) Obtain the test sample materials during the day at appropriate times that will ensure the maximum deviance in the components of the fiber-reinforced composite.
 - b) Prepare the test samples on a smooth, flat, level surface covered with polyethylene sheeting, or 16 mil thick plastic film, that has been primed with epoxy.
 - c) Place a layer of saturated fabric on the epoxy-covered sheeting or film, ~~and apply an additional topping of epoxy.~~
 - d) Cover the sample with plastic film, and squeeze out all bubbles.
 - e) Identify the test samples, and store the samples in a sample box where they will not be moved for a minimum of 48 hours after casting.
 - 2) Submit the test samples to Program/Project Manager.





- 3) The Testing and Inspection Agency will precondition the test samples for 48 hours at 140 degrees Fahrenheit (60 degrees Celsius) before performing the testing.
- 4) The Testing and Inspection Agency will cut test specimens from the test samples.
- 5) The Testing and Inspection Agency will determine the tensile strength, tensile modulus, and percentage elongation in the longitudinal fiber direction in accordance with the methods specified in ASTM D 3039/D 3039M.
- 6) The Testing and Inspection Agency will test a minimum of 15 percent of all test samples in accordance with the requirements specified in ICC-ES AC178.
 - a) If one coupon fails, additional coupon specimens from the same test sample will be tested.
 - b) If the additional test coupons also fail, the second 12-inch by 12-inch (300mm by 300mm) swatch from the same test sample will be tested.
 - c) If the coupons from the second 12-inch by 12-inch (300mm by 300mm) swatch also fail the testing, the remaining test samples from the same day will be tested; and in addition, 25 percent of the remaining samples will be tested using the criteria specified in ICC-ES AC178.
- 7) The Testing and Inspection Agency will make test results available to the Program/Project Manager within 3 weeks of the submission of the test samples.
- b. Acceptance Criteria:
 - 1) Site test samples whose design values are lower than the calculated mean determined from the test results from the testing performed in accordance with the methods specified in ASTM D 3039/D 3039M pass the Fiber-Reinforced Polymer Concrete Rehabilitation Test.
 - a) Acceptable minimum values for the tensile strength, tensile modulus, and percentage elongation may not be below the submitted design values.
 - b) Test samples having values below the submitted design values are considered to be failures, and material represented by the failed test samples require remedial work.
3. Inspections:
 - a. Concrete Rehabilitation Report:
 - 1) Monitor the mixing of the fiber-reinforced polymer concrete rehabilitation system to assure the proper ratio of components, as recommended by the manufacturer, is maintained.
 - 2) Each day, record the batch numbers of the fabric and epoxy used, the square footage of fabric and the volume of epoxy applied, and the locations where the system is installed during the day.



- 3) Report shall include results of testing done by In-Situ Tensile Pull-Off Tests (ICR Guideline 210.3-2004) that evaluate both the clean prepared concrete surface and the bonding of the CFRP to the existing Concrete members.
 - 4) Prepare a Concrete Rehabilitation Report signed and sealed by a Professional Engineer, and that documents the information recorded, includes the test reports and photographs taken of the repaired areas, and certifies that the installation is acceptable.
 - a) Submit the report to the Program/Project Manager for information.
 - b. Special Inspections:
 - 1) The Approved Agency will periodically observe the preparation, mixing, and application of the fiber-reinforced polymer concrete rehabilitation system.
 - 2) The Approved Agency will inspect all areas where the concrete rehabilitation system has been applied for voids, bubbles, and delaminations in accordance with the manufacturer's recommendations.
- B. Non-Conforming Work
1. Remove carbon fiber reinforced polymer (CFRP) determined to be non-conforming, and replace the non-conforming items removed with Work that conforms to the specified requirements.

3.06 CLEANING

- A. Upon completion of the Work of this Section, remove equipment, surplus concrete rehabilitation material, and debris from the Site.
- B. Waste Management:
1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	07/13/2018	N/A	All	First edition.





SECTION 04810

UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing the following unit masonry assemblies:
 - a. Concrete masonry units (CMUs).
 - b. Glass block set in mortar.
 - c. Face brick.
 - d. Mortar and grout.
 - e. Reinforcing steel.
 - f. Masonry joint reinforcement.
 - g. Ties and anchors.
 - h. Embedded flashing.
 - i. Miscellaneous masonry accessories
- B. Products Supplied But Not Installed Under This Section:
 - 1. Dovetail slots for masonry anchors, installed under Section 03300, Cast-In-Place Concrete.
 - 2. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Section 05120, Structural Steel.
- C. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 03300 – Cast-In-Place concrete.
 - 6. Section 05120 – Structural Steel.
 - 7. Section 05500 – Metal Fabrications.
 - 8. Section 07620 - Sheet Metal Flashing and Trim.
 - 9. Section 07850 - Through-Penetration Firestopping Systems.
 - 10. Section 07920 – Joint Sealants

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called



“credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
2. Cementitious Material: A mixture of cement and fly ash.
3. Reglet: A groove for guiding or holding a panel, window sash, or similar item; or a narrow, flat molding.
4. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

C. Reference Standards:

1. American Concrete Institute (ACI):
 - a. ACI 315 - Details and Detailing of Concrete Reinforcement.
2. American Concrete Institute (ACI)/American Society of Civil Engineers (ASCE)/The Masonry Society (TMS):
 - a. ACI 530/ASCE 5/TMS 402 – Building Code Requirements for Masonry Structures.
 - b. ACI 530.1/ASCE 6/TMS 602 - Specifications for Masonry Structures.
3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 82/A 82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - c. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - d. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - e. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - f. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - g. ASTM A 563M - Standard Specification for Carbon and Alloy Steel Nuts.
 - h. ASTM A 580/A 580M - Standard Specification for Stainless Steel Wire.
 - i. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - j. ASTM A 641/A 641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - k. ASTM A 663/A 663M - Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.



- l. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
- m. ASTM A 951/A 951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
- n. ASTM A 996/A 996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
- o. ASTM B 32 - Standard Specification for Solder Metal.
- p. ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- q. ASTM C 90 - Standard Specification for Loadbearing Concrete Masonry Units.
- r. ASTM C 140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- s. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
- t. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.
- u. ASTM C 150 - Standard Specification for Portland Cement.
- v. ASTM C 185 - Standard Test Method for Air Content of Hydraulic Cement Mortar.
- w. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- x. ASTM C 216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
- y. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
- z. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout.
- aa. ASTM C 476 - Standard Specification for Grout for Masonry.
- bb. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
- cc. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- dd. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.
- ee. ASTM C 954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
- ff. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
- gg. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout.
- hh. ASTM C 1093 - Standard Practice for Accreditation of Testing Agencies for Unit Masonry.
- ii. ASTM C 1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
- jj. ASTM C 1329 - Standard Specification for Mortar Cement.



- kk. ASTM D 1056 - Standard Specification for Flexible Cellular Materials-
Sponge or Expanded Rubber.
- ll. ASTM D 2000 - Standard Classification System for Rubber Products
in Automotive Applications.
- mm. ASTM D 2287 - Standard Specification for Nonrigid Vinyl Chloride
Polymer and Copolymer Molding and Extrusion Compounds.
- nn. ASTM E 119 - Standard Test Methods for Fire Tests of Building
Construction and Materials.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. Concrete Masonry Association of California and Nevada (CMACN):
 - a. CMACN MIAV6 - Quality Control of Masonry – Part I (Mortar, Grout,
Steel).
 - b. CMACN MIAV7 - Quality Control of Masonry – Part II (Brick).
 - c. CMACN MIAV8 - Quality Control of Masonry – Part III (Concrete
Block).
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of
Phoenix.
- 7. National Concrete Masonry Association (NCMA):
 - a. NCMA TEK 8-2A – Removal of Stains from Concrete Masonry.
- 8.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky
Harbor International Airport to insure notification is received sufficiently
early to allow them ample time to schedule and perform the required
testing performed by the Testing and Inspection Agency, the Approved
Agency, and the City, prior to incorporating items requiring testing by them
into the Work.
 - 2. Direct and coordinate the placement of metal anchors supplied under this
Section for installation under other Sections.
- B. Pre-Installation Meetings:
 - 1. Attend a pre-installation meeting at the Site held in compliance with the
requirements of Section 01316, Project Meetings, to discuss the
requirements for constructing the unit masonry assemblies to be provided
under this Contract.
- C. Sequencing:
 - 1. Do not apply uniform floor, roof, loads, or concentrated loads for at least 3
days after grouting masonry walls or columns.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Concrete masonry units.
 - 2) Mortar mix designs.
 - 3) Grout mix designs.
 - 4) Reinforcing steel.
 - 5) Masonry joint reinforcement.
 - 6) Masonry ties and anchors.
 - 7) Stainless-steel drill screws for steel studs.
 - 8) Embedded flashing materials.
 - 9) Compressible filler.
 - 10) Pre-formed control joint gaskets.
 - 11) Weep/vent tubing.
 - 12) Cavity drainage material.
 - 13) Reinforcing bar positioners.
 - 14) Masonry cleaners.
 - 15) List of materials used in constructing mockups.
 - b. Shop Drawings:
 - 1) Masonry Units.
 - 2) Reinforcing steel.
 - 3) Fabricated flashing.
 - c. Samples:
 - 1) Full-size Samples for initial selection of exposed concrete masonry units.
 - 2) Full-size Samples for verification of glass block unit and joint materials involving color selection.
 - 3) Samples for initial selection of colored mortar.
 - 4) Samples for verification of exposed concrete masonry units.
 - 5) Samples for verification of weep holes/vents.
 - 6) Samples for verification of accessories to be embedded in the masonry.
 - d. Certificates:
 - 1) Manufacturer's Material Certificates for each type of masonry unit required.
 - 2) Manufacturer's Material Certificates for-cementitious materials.
 - 3) Manufacturer's Material Certificates for each combination of masonry unit type and mortar type.
 - 4) Manufacturer's Material Certificates for each reinforcing bar material and grade.
 - 5) Manufacturer's Material Certificates for each joint reinforcement type and size.



- 6) Manufacturer's Material Certificates for each type and size of anchor, tie, and metal accessory.
- e. Special Procedure Submittals:
 - 1) Cold-weather procedures.
 - 2) Hot-weather procedures.
 - 3) Engineering data, when required by the Authorities Having Jurisdiction (AHJ) to obtain a separate permit.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Manufacturer's Concrete Masonry Unit Test reports.
 - b. Site Quality Control Submittals:
 - 1) Installer's field report.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements
 - a. Sustainable Design Submittal Documentation:
 - 1) ENVISION Credit RA1.4 – Use Regional Materials: At least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - 2) ENVISION Credit RA1.3, Use Recycled Materials: At least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Inspector.



- c. Both continuous and periodic Special Inspections will be performed during the erection of unit masonry assemblies.
- 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
 - 1) The independent Testing and Inspection Agency must be qualified according to ASTM C 1093 to conduct the testing indicated, and must be acceptable to the Authorities Having Jurisdiction.

B. Certifications:

- 1. Manufacturer's Material Certificates of Compliance:
 - a. Submit material certificates, signed by the manufacturers, to the Program/Project Manager that certify each type and size of the following items complies with the specified requirements, including compliance with the referenced standards and the type designations within the standards:
 - 1) Masonry units:
 - a) Include material test reports and substantiating compliance with the requirements.
 - b) For bricks, include size-variation data verifying that the actual range of sizes falls within the specified tolerances.
 - c) For exposed brick, include a material test report for efflorescence complying with the requirements specified in ASTM C 67.
 - d) For masonry units used in structural masonry, include data and calculations establishing the average net-area compressive strength of the units.
 - 2) Cementitious Materials:
 - a) For each cement product required for mortar and grout, include the brand, type, name of the manufacturer, and weight slips at the time of delivery.
 - b) Pre-Blended, Dry Mortar Mixes:
 - (1) Include a description of the type and proportions of ingredients.
 - c) Grout Mixes:
 - (1) Include a description of the type and proportions of ingredients.
 - 3) Combination of Masonry Unit Type and Mortar Type:
 - a) For each combination of masonry unit type and mortar type, include a statement certifying the net-area compressive strength of the masonry units, the mortar type, and the net-area compressive strength of the masonry determined



according to Table 2105.2.2.1.2 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.

- 4) Reinforcing Bars:
 - a) Include each material and grade indicated in the Contract Documents.
- 5) Joint Reinforcement:
 - a) Include each type and size of joint reinforcement.
- 6) Anchors, Ties, and Metal Accessories:
 - a) Include each type and size of anchor, tie, and metal accessory.

C. Preconstruction Testing:

- 1. The Testing and Inspection Agency may perform preconstruction testing of materials as follows:
 - a. Clay Masonry Unit Test:
 - 1) Test Procedure:
 - a) Each type of clay masonry unit required will be tested in accordance with the methods specified in ASTM C 67 and Chapter 21 of the Phoenix Building Construction Code and Amendments.
 - 2) Acceptance Criteria:
 - a) Clay masonry units complying with the criteria listed in Table 2105.2.2.1.1 of the Phoenix Building Construction Code and Amendments passes the Clay Masonry Unit Test.
 - b. Concrete Masonry Unit Test:
 - 1) Test Procedure:
 - a) Each type of concrete masonry unit required will be tested in accordance with the methods specified in ASTM C 140 and Chapter 21 of the Phoenix Building Construction Code and Amendments.
 - 2) Acceptance Criteria:
 - a) Concrete masonry units complying with the criteria listed in Table 2105.2.2.1.2 of the Phoenix Building Construction Code and Amendments passes the Concrete Masonry Unit Test.
 - c. Grout (Compressive Strength) Test:
 - 1) Test Procedure:
 - a) Each type of grout required will be tested in accordance with the methods specified in ASTM C 1019 and Chapter 21 of the Phoenix Building Construction Code and Amendments.
 - 2) Acceptance Criteria:
 - a) Grout complying with the compressive strength criteria listed in ASTM C 476 passes the Grout (Compressive Strength) Test.

D. Site Samples:

- 1. Samples for Initial Selection:



- a. Submit the following Samples to the Program/Project Manager for selection of the initial materials:
 - 1) For exposed concrete masonry units, [3] full-size Sample units.
 - 2) Colored mortar Samples.
 2. Samples for Verification:
 - a. Submit the following Samples to the Program/Project Manager for verification of the initial selections:
 - 1) Exposed concrete masonry Samples units.
 - 2) Samples of pigmented mortar, made using the same sand and mortar ingredients to be used for the Contract Work.
 - 3) Weep holes/vent Samples matching the color of the mortar color.
 - 4) Samples of accessories to be embedded in the masonry.
- E. Mock-ups:
 1. Build mockups of typical wall areas as shown on the Contract Drawings to verify selections made under the Sample submittals, to demonstrate the aesthetic effects of the materials, and to set quality standards for materials and execution.
 - a. Locate the mock-up(s) where directed by the Program/Project Manager.
 - b. The approval of mockups is for the color, texture, and blending of masonry units; the relationship of the mortar and sealant colors to the masonry unit colors; the tooling of joints; and the aesthetic qualities of workmanship.
 - c. The approval of mockups may also be for other material and construction qualities specifically approved by the Program/Project Manager in writing.
 - d. The approval of mockups does not constitute approval of deviations from the requirements of the Contract Documents contained in the mockups unless such deviations are specifically approved by the Program/Project Manager in writing.
 2. Construct masonry wall mock-up panels sized [5 feet] long by [4 feet] high, which include mortar and accessories, structural backup, flashings, and wall insulation.
 - a. Erect separate panels for each type of unit masonry work.
 - b. In exterior wall mockups, include a sealant-filled joint that is at least 16 inches long; a window opening, complete with a window frame and associated flashing; and flashing installed for the length of the mockup approximately 16 inches below the top of the mockup, including a 24-inch length of flashing where the masonry above the flashing remains uninstalled so the flashing is left exposed to view.
 3. Clean one-half of the exposed faces of mock-ups with masonry cleaner as specified in Article 3.06.
 - a. Apply anti-graffiti coating to cleaned halves of concrete masonry unit mock-ups.



4. Protect accepted mockups from the elements by using a weather-resistant membrane.
5. Do not proceed with masonry Work until the Program/Project Manager has approved the mock-up panel.
6. Do not destroy or move the panel until the Contract Work is completed and accepted by the Program/Project Manager.
 - a. Approved mock-ups may become part of the completed Work if the mock-ups remain undisturbed at the time of Substantial Completion.
 - 1) If the mock-ups are not permitted to be part of the finished Work, demolish and remove them from the Site upon completion and acceptance of the Work of this Section.
7. List of Materials Used in Constructing Mockups:
 - a. As required to identify the materials used for each mock-up, prepare and submit a list of the materials' generic product names, manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information to the Program/Project Manager for information.
 - 1) Include mix proportions for mortar and grout, and the source of aggregates.
 - 2) Neither the receipt of this list nor the approval of the mock-up constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of the Program/Project Manager and approved in writing.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Mortar:
 - a. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into a dispensing silo.
- B. Storage and Handling Requirements:
 1. Masonry Units:
 - a. Store masonry units on elevated platforms in a dry location.
 - b. If the units are not stored in an enclosed location, cover the tops and sides of the stacks with waterproof sheeting, securely tied.
 - 1) Protect concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.
 - 2) If the units become wet, do not install them until they are dry.
 2. Cementitious Materials:
 - a. Store cementitious materials on elevated platforms, under cover, and in a dry location.
 - b. Do not use cementitious materials that have become damp.
 3. Aggregates:
 - a. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.



4. Masonry Accessories:
 - a. Store masonry accessories, including metal items, so corrosion and the accumulation of dirt and oil is prevented.
5. Mortar:
 - a. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location, or in a metal dispensing silo with a weatherproof cover.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Cold-Weather Requirements:
 - a. Do not use frozen materials or materials mixed or coated with ice or frost.
 - b. Do not build on frozen substrates.
 - c. Remove and replace unit masonry damaged by frost or by freezing conditions.
 - d. Comply with the cold-weather construction requirements contained in Part 1.8C of ACI 530.1/ASCE 6/TMS 602 as may be amended by the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - e. Cold-Weather Cleaning:
 - 1) Use liquid cleaning methods only when the air temperature is 40 degrees Fahrenheit (4 degrees Celsius) and above, and will remain so until the masonry has dried, but not less than 7 days after completing cleaning.
 - f. Submit cold-weather procedures with detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements and a curing procedure to the Program/Project Manager for approval.
2. Hot-Weather Requirements:
 - a. Protect unit masonry work when the temperature and humidity conditions produce excessive evaporation of water from the mortar and grout.
 - 1) Provide artificial shade and wind breaks, and use cooled materials as required.
 - 2) For additional information refer to Part 1.8D of ACI 530.1/ASCE 6/TMS 602 as may be amended by the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. When the ambient temperature exceeds 100 degrees Fahrenheit (38 degrees Celsius) or 90 degrees Fahrenheit (32 degrees Celsius) with



a wind velocity greater than 8 mph (13 km/h), do not spread mortar beds more than 48 inches (1200mm) ahead of the masonry.

- c. Maintain the temperature of mortar and grout below 120 degrees Fahrenheit (48.9 degrees Celsius).
- d. Maintain the consistency of the mortar by using cool water.
- e. Use the mortar within 2 hours of the initial mixing.
- f. Set masonry units within 1 minute of spreading the mortar.
- g. Submit hot-weather procedures with detailed description of methods, materials, and equipment to be used to comply with hot-weather requirements and a curing procedure to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 UNIT MASONRY ASSEMBLIES

A. Manufacturers:

1. Substitution Limitations:

a. Source Limitations for Masonry Units:

- 1) Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

b. Source Limitations for Mortar Materials:

- 1) Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

B. Performance:

1. Compressive Strengths (f'm):

a. Provide unit masonry that develops net-area compressive strengths (f'm) at 28 days as required by the "General Structural Notes" on the Contract Drawings.

- 1) Determine the compressive strength of clay masonry from the net-area compressive strengths of the masonry units and mortar types according Table 2105.2.2.1.1 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 2) Determine the compressive strength of concrete masonry from the net-area compressive strengths of the masonry units and mortar types according Table 2105.2.2.1.2 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.

2. Fire-Resistance Ratings:

- a. Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined in accordance with the methods specified in ASTM E 119 by a testing and inspecting agency, by providing an equivalent concrete masonry thickness, or by another means acceptable to the Authorities Having Jurisdiction.



C. Design Criteria

1. Masonry Reinforcement:
 - a. Do not provide unreinforced masonry walls.
2. Product Data:
 - a. Submit the manufacturer's Product Data for each type of product indicated in the Contract Documents and provided.
 - 1) Provide Product Data for each different type, finish, and shape of concrete masonry units to be used.
3. Shop Drawings:
 - a. Prepare Shop Drawings showing both fabrication and installation details for the following items.
 - 1) Masonry Units:
 - a) Show the sizes, profiles, coursing, and locations of special shapes.
 - 2) Reinforcing Steel:
 - a) Detail the bending and placement of the unit masonry reinforcing bars.
 - b) Comply with the requirements specified for detailing concrete reinforcement in ACI 315.
 - c) Show the elevations of reinforced walls.
 - 3) Fabricated Flashing:
 - a) Detail corner units, end-dam units, and other special applications.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval:

D. Materials:

1. Concrete Masonry Units:
 - a. Sustainability Requirements: Regional Content – Provide Concrete Masonry Units that are manufactured and whose raw materials are extracted within a 500 mile radius of the project site.
 - b.
 - c. Provide concrete masonry units complying with the requirements specified in ASTM C 90 for Standard Unit precision; and having the minimum average net-area compressive strength of 3 units, weight classification, and size (width) indicated on the Contract Drawings.
 - 1) Provide concrete masonry units complying with the quality control standards of the Concrete Masonry Association of California and Nevada.
 - 2) Provide units steam-cured or yard air cured for 28 days.
 - 3) Unless otherwise indicated or specified, provide natural cement color smooth faced units.
 - d. Exposed Faces:
 - 1) Unless otherwise indicated in the Contract Documents, provide concrete masonry units having exposed faces of the manufacturer's standard color and texture.



- 2) Where units are to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
- 3) Where units are to be left exposed, provide the color and texture matching the range represented by Program/Project Manager's Sample.
 - a) Color Pigment:
 - (1) Provide masonry units with integral color pigment complying with ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, non-fading, and resistant to lime and other alkalis.
- e. Special Shapes:
 - 1) For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions, provide special shapes.
 - a) Include matching jamb, lintel, control joint, bond beam, wall cap, and other special shape, type, or size units as required.
 - 2) For interior outside corners, provide bullnose units unless otherwise indicated in the Contract Documents.
 - 3) For exterior outside corners, provide square-edged units unless indicated as bullnose in the Contract Documents.
- f. Exterior/Interior Masonry Unit Types:
 - 1) Provide the types of masonry units indicated on the Contract Drawings.
 - 2) If the types of masonry units are not indicated on the Contract Drawings, provide Type 1, 8-inch by 8-inch by 16-inch, standard face, gray colored units.
2. Glass Block:
 - a. Hollow units made from transparent glass, with manufacturer's standard edge coating.
 - b. Pittsburgh Corning Corp.; www.pittsburghcorning.com
 - c. Approved equal.
 - d. Glass Color: Colorless.
 - e. Pattern: Smooth, undistorted inner and outer faces.
 - f. Sizes: Manufacturer's standard sizes corresponding to nominal sizes indicated on Drawings.
 - g. Thick-Faced Block: Units with faces at least $\frac{3}{4}$ inch (19 mm) thick.
3. Mortar and Grout Materials:
 - a. Portland Cement:
 - 1) Provide Portland cement complying with the requirements for Type II cement specified in ASTM C 150.
 - 2) Provide natural color or white cement as required to produce the mortar color indicated.
 - b. Hydrated Lime:
 - 1) Provide hydrated lime complying with the requirements for Type S lime specified in ASTM C 270.
 - c. Portland Cement-Lime Mix:



- 1) Provide a packaged blend of Portland cement complying with the requirements for Type II cement specified in ASTM C 150, and Type S hydrated lime complying the requirements specified in ASTM C 207.
- d. Mortar Cement:
 - 1) Provide mortar cement complying with the requirements specified in ASTM C 270 and ASTM C 1329, and having maximum air content of 12 percent when tested in accordance with the method specified in ASTM C 185.
 - 2) Do not use masonry Cement.
- e. Aggregate for Mortar:
 - 1) Provide aggregate complying with the requirements specified in ASTM C 144; except for joints less than 1/4 inch (6.5mm) thick, use aggregate having a gradation so 100 percent passes the No. 16 (1.18mm) sieve.
 - 2) For mortar that is exposed to view, provide washed aggregate consisting of natural sand or crushed stone.
- f. Colored-Mortar Aggregates:
 - 1) Provide natural-colored sand or ground marble, granite, or other sound stone of the color necessary to produce the required mortar color.
- g. Aggregate for Grout:
 - 1) Provide aggregate complying with the requirements specified in ASTM C 404.
- h. Mortar Pigments:
 - 1) Provide natural and synthetic iron oxide and chromium oxide pigments compounded for use in mortar mixes.
 - 2) Use only pigments with a record of satisfactory performance in masonry mortar.
 - 3) Manufacturers:
 - a) Bayer AG, Lanxess, Bayferrox® Iron Oxide Pigments, www.bayferrox.com.
 - b) Davis Colors; True Tone Mortar Colors, www.daviscolors.com.
 - c) Solomon Colors, Inc.; SGS Mortar Colors, www.solomoncolors.com.
 - d) Approved equal.
- i. Cold-Weather Admixtures:
 - 1) Provide non-chloride, noncorrosive, accelerating admixtures complying with the requirements for Type C admixtures specified in ASTM C 494/C 494M, and recommended by the manufacturer for use in masonry mortar of the composition indicated.
- j. Water-Repellent Admixtures:
 - 1) Provide liquid water-repellent mortar admixtures intended for use with concrete masonry units containing integral water repellent by the same manufacturer.



- k. Water:
 - 1) Provide potable water.
- 4. Reinforcing Steel:
 - a. Sustainability Requirements: Recycled Content – Provide Steel Reinforcement whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
 - b. Uncoated Steel Reinforcing Bars:
 - 1) Provide uncoated steel reinforcing bars complying with the requirements for Grade 60 (Grade 420) steel specified in ASTM A 615/A 615M or ASTM A 996/A 996M.
 - 2) Wherever number 2 steel reinforcing bars are indicated in the Contract Documents or otherwise required, provide plain steel reinforcement bars complying with the requirements for Grade 80 bars specified in ASTM A 663/A 663M.
 - c. Cold-Drawn Steel Wire:
 - 1) Provide cold-drawn steel wire complying with the requirements specified in ASTM A 82/A 82M.
 - d. Welded Steel Wire Fabric:
 - 1) Provide welded steel wire fabric complying with the requirements specified in ASTM A 185/A 185M.
 - e. Truss Type:
 - 1) Do not provide truss type masonry joint reinforcement.
 - f. Ladder Type:
 - 1) Provide mill-galvanized, carbon steel, hot-dip galvanized carbon steel, or stainless-steel ladder type reinforcing 2 inches less in width than the nominal wall thickness.
 - 2) Manufacturers:
 - a) Dayton Superior Corporation, Dur-O-Wal Division;
www.daytonsuperior.com/DurOWal-main.html.
 - b) Approved equal.
- 5. Masonry Joint Reinforcement:
 - a. Provide galvanized ladder type masonry joint reinforcement complying with the requirements specified in ASTM A 951/A 951M.
 - b. For both interior and exterior walls, provide mill galvanized, carbon-steel wire as follows:
 - 1) Wire Size for Side Rods: W1.7 or 0.148 inch (3.8mm) diameter.
 - 2) Wire Size for Cross Rods: W1.7 or 0.148 inch (3.8mm) diameter.
 - c. Provide masonry joint reinforcement in lengths of not less than 10 feet (3m), with prefabricated corner and tee units where indicated on the Contract Drawings.
 - d. Masonry Joint Reinforcement for Single-Wythe Masonry:
 - 1) Provide ladder type masonry joint reinforcement with a single pair of side rods and cross rods spaced not more than 16 inches (407mm) apart on center.
- 6. Masonry Ties and Anchors:



- a. Unless otherwise indicated in the Contract Documents, provide ties and anchors fabricated from carbon steel wire complying with the requirements specified in ASTM A 82/A 82M mill galvanized with a Class 1 coating complying with the requirements specified in ASTM A 641/A 641M; and from steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - 1) If stainless steel wire is indicated for anchors, provide type 304 stainless steel wire complying with the requirements specified in ASTM A 580/A 580M.
 - 2) If stainless steel sheet is indicated for anchors, provide type 304 stainless steel wire complying with the requirements specified in ASTM A 666.
- b. Adjustable Masonry-Veneer Anchors:
 - 1) Provide two-piece vertically or horizontally adjustable masonry-veneer anchor assemblies designed for attachment over sheathing to wood or metal studs.
 - 2) Provide masonry-veneer anchors capable of withstanding a 100 pounds force (445N) load in either tension or compression perpendicular to the plane of the wall without deforming or developing play in excess of 0.05 inch (1.3mm).
- c. Miscellaneous Anchors:
 - 1) Provide the following miscellaneous anchors as required:
 - a) Unit Concrete Inserts:
 - (1) Provide cast-iron or malleable-iron unit inserts for concrete of the type and size indicated on the Contract Drawings.
 - b) Dovetail Slots:
 - (1) Provide dovetail slots fabricated from 0.0336 inch (0.85mm) thick galvanized steel sheet, of the slot size indicated on the Contract Drawings, and having filler strips.
 - c) Anchor Bolts:
 - (1) Provide anchor bolts fabricated from Grade A steel complying with the requirements specified in ASTM A 307, with hex nuts complying with the requirements specified in ASTM A 563 or ASTM A 563M as applicable, and where indicated having flat washers.
 - (a) For exposed exterior anchors, provide Type 304 stainless steel anchors having minimum corrosive resistances.
 - (2) Provide headed bolts of the diameter and length indicated in the Contract Documents; do not provide non-headed (J and L) bolts.
- 7. Stainless-Steel Drill Screws for Steel Studs:
 - a. For steel studs from 0.033 to 0.112 inch (0.8 to 2.8 mm) thick, provide proprietary fasteners consisting of a carbon-steel drill point and a



- 300 Series stainless-steel shank, and complying with the requirements specified in ASTM C 954; except manufactured with a hex washer head and neoprene washer
- b. Provide fasteners having No. 10 diameters and the lengths required to penetrate the steel stud flange with not less than 3 exposed threads.
 - c. Manufacturers:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Stainless Steel SX Fastener, www.daytonsuperior.com/DurOWal-main.html.
 - 2) ITW Buildex; Scots long life Tekes, www.itwbuildex.com.
 - 3) Approved equal.
8. Embedded Flashing Materials:
- a. Metal Flashing:
 - 1) Provide embedded flashing complying with the requirements specified in Section 07620, Sheet Metal Flashing and Trim, and the following:
 - a) Unless otherwise indicated in the Contract Documents, provide flashing fabricated from 10 ounce per square foot ($3\text{kg}/\text{m}^2$) weight, or 0.0135 inch (0.34mm) thick, copper for fully concealed flashing.
 - b) Unless otherwise indicated in the Contract Documents, provide flashing fabricated from 16 ounce per square foot ($5\text{kg}/\text{m}^2$) weight, or 0.0216 inch (0.55mm) thick, copper for other than fully concealed flashing.
 - c) If stainless steel flashing is indicated in the Contract Documents, provide 0.016 inch thick Type 304 stainless steel complying with the requirements specified in ASTM A 240/A 240M.
 - 2) Fabricate continuous flashings in 96-inch long sections at a minimum, but do not provide flashing exceeding 12 feet in length.
 - a) Provide splice plates at the joints of formed, smooth metal flashing.
 - 3) For through-wall metal flashing embedded in masonry, fabricate the flashing from sheet metal as specified in Subparagraph 3.05.F.1, but having ribs at 3 inch (75mm) intervals along the length of the flashing designed to provide an integral mortar bond.
 - 4) For metal expansion-joint strips, fabricate the flashing from sheet metal as specified in Subparagraph 3.05.F.1, but formed to the shape indicated on the Contract Drawings.
 - 5) For metal drip edges, fabricate the flashing from sheet metal as specified in Subparagraph 3.05.F.1, but extending at least 3 inches (75mm) into the wall and 1/2 inch (13mm) out from wall, with a hemmed outer edge bent down 30 degrees.
 - 6) For metal flashing terminations, fabricate the flashing from sheet metal as specified in Subparagraph 3.05.F.1, but extending at least 3 inches (75mm) into the wall and out to the exterior face of the wall where the metal is bent back on itself for 3/4 inch (19mm)



and then down 3/8 inch (10mm) into the joint to form a stop for retaining sealant backer rod.

- b. Flexible Flashing:
 - 1) For flexible flashing not exposed to the exterior, unless otherwise indicated provide composite rubberized-asphalt flashing consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - 2) Manufacturers:
 - a) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing, www.carlisle-ccw.com.
 - b) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing, www.na.graceconstruction.com.
 - c) Polytite Manufacturing Corp.; Poly-Barrier Self-Adhering Wall Flashing.
 - d) Approved equal.
- c. Solder and Sealants for Sheet Metal Flashings:
 - 1) Solder for Stainless Steel:
 - a) Provide solder complying with the requirements for Grade Sn60 solder specified in ASTM B 32, with acid flux of a type recommended by the stainless-steel sheet manufacturer.
 - 2) Elastomeric Sealant:
 - a) Provide chemically curing silicone elastomeric sealant complying with the requirements specified in ASTM C 920, and of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim while remaining watertight.
- d. Adhesives, Primers, and Seam Tapes for Flexible Flashings:
 - 1) Provide the flashing manufacturer's standard products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.02 MIXES:

- A. Mortar and Grout Mixes:
 - 1. Unless otherwise indicated in the Contract Documents, do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures.
 - a. Do not use calcium chloride in mortar or grout.
 - b. Limit cementitious materials in mortar to Portland cement and lime.
 - c. If cold-weather admixture is used, add the admixture at the same rate for all mortar regardless of weather conditions to ensure that the mortar color is consistent.
 - 2. Pre-blended, Dry Mortar Mix:



- a. Provide dry mortar ingredients in the form of a pre-blended mix.
- b. Portland Cement-Lime Mix:
 - 1) Provide a packaged blend of Portland cement complying with the requirements for Type I or Type III specified in ASTM C 150, and hydrated lime complying with the requirements for Type S specified in ASTM C 207.
- c. Measure the quantities by weight to ensure accurate proportions, and thoroughly blend the ingredients before delivering the mix to the Site.
3. Mortar for Unit Masonry:
 - a. Provide Type S or Type M mortar for unit masonry complying with the Proportion Specification requirements specified in ASTM C 270.
 - 1) Do not use masonry cement.
 - 2) Provide cement-lime mortar; however, mortar cement may be used if it is proportioned as specified in ASTM C 270, has maximum air content of 12 percent when tested in accordance with the method specified in ASTM C 185, and complies with the requirements specified in ASTM C 1329.
 - 3) For masonry below grade or in contact with earth, provide Type M mortar.
 - 4) For reinforced masonry, provide Type S mortar.
 - a) Provide mortar complying with the property requirements for Type S mortar specified in ASTM C 270, using Type II Portland cement complying with the requirements specified in ASTM C 150 and lime.
4. Mortar for Glass Unit Masonry:
 - a. Comply with ASTM C 270, Proportion Specification for Type S mortar.
5. Grout for Unit Masonry:
 - a. Provide grout for unit masonry complying with the requirements specified in ASTM C 476, and having a slump of 8 to 11 inches (200 to 280mm) when measured in accordance with the requirements specified in ASTM C 143/C 143M.
 - 1) Provide grout mixes complying with ASTM C 476 and the specified minimum compressive strength indicated in the General Structural Notes on the Contract Drawings.
 - b. Provide grout of type indicated in the Contract Documents.
 - 1) If the type of grout is not indicated, provide fine or coarse grout of the type indicated in Table 2103.12 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - c. Depending on the dimensions of the grout space, provide fine or coarse grout in accordance with the requirements of Table 7 in ACI 530.1/ASCE 6/TMS 602.
 - 1) The maximum pour height without cleanouts is 5 feet.
 - 2) The maximum pour height with cleanouts is 9 feet.

- B. Submit the mortar and grout mix designs to the Program/Project Manager for approval.



1. Include a description of type and proportions of grout ingredients.
2. For mortar mixes required to comply with a property specification, provide test results indicating the properties when tested in accordance with the requirements specified in ASTM C 270
3. For grout mixes, provide test results indicating the grout compressive strength when tested in accordance with the requirements specified in ASTM C 476.

2.03 ACCESSORIES

A. Glass Unit Masonry Accessories

1. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A 951 in straight lengths of not less than 10 feet (3m) and as follows:
 - a. Exterior Walls: hot-dip galvanized, carbon wire
 - b. Wire Size: W1.7 or 0.148-inch (3.8 mm) diameter
 - c. Width: 2 inches (50 mm)
 - d. Spacing of Cross Rods: Not more than 16 inches apart.
2. Panel Anchors: Glass block manufacturer's standard perforated steel strips, 0.0359 inch (0.9 mm) by 1-3/4 inches (44 mm) wide by 24 inches (600 mm) long, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Fasteners, General; Unless otherwise indicated, provide Type 304 or Type 316 stainless steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade and class required.
4. Asphalt emulsion: Cold-applied asphalt emulsion complying with ASTM D 1187 or ASTM D1227.

B. Compressible Filler:

1. Provide pre-molded filler strips complying with the requirements for Grade 2A1 neoprene material specified in ASTM D 1056.
2. Provide strips that are compressible up to 35 percent, and of the width and thickness indicated in the Contract Documents.

C. Preformed Control-Joint Gaskets:

1. Provide preformed control-joint gaskets designed to fit standard sash blocks, and to maintain lateral stability in masonry walls.
 - a. Provide gaskets sized and configured as indicated on the Contract Drawings.
 - b. Provide gaskets fabricated from either Styrene-Butadiene-Rubber complying with the requirements for Compound Designation M2AA-805 specified in ASTM D 2000, or polyvinyl chloride complying with the requirements for Type PVC-65406 specified in ASTM D 2287.

D. Weep/Vent Tubing:



1. Provide plastic weep/vent tubing fabricated from round 3/8 inch (9mm) outside diameter (OD) medium-density polyethylene, and 4 inches (100mm) long.
 2. Manufacturers:
 - a. Advanced Building Products Inc.; Mortar Maze weep vent, www.advancedflashing.com.
 - b. Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents, www.daytonsuperior.com/DurOWal-main.html.
 - c. Heckmann Building Products Inc.; No. 85 Cell Vent, <http://www.heckmannbuildingprods.com/>.
 - d. Hohmann & Barnard, Inc.; Quadro-Vent, www.h-b.com.
 - e. Wire-Bond; Cell Vent, www.wirebond.com.
 - f. Approved equal.
- E. Cavity Drainage Material:
1. Provide free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 2. Provide strips the full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent the mesh from being clogged with mortar droppings.
 3. Manufacturers:
 - a. Advanced Building Products Inc.; Mortar Break, www.advancedflashing.com.
 - b. Archovations, Inc.; CavClear® Masonry Mat, www.cavclear.com.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop, www.daytonsuperior.com/DurOWal-main.html.
 - d. Mortar Net USA, Ltd.; Mortar Net, www.mortarnet.com.
 - e. Approved equal.
- F. Reinforcing Bar Positioners:
1. Provide wire reinforcing bar positioners designed to fit into the mortar bed joints spanning masonry unit cells, and with loops for holding reinforcing bars in the center of the cells.
 - a. Provide units formed from 0.142 inch (3.6mm) steel wire, hot-dip galvanized after fabrication.
 - b. Provide units with either 2 loops or 4 loops as needed for the number of bars indicated on the Contract Drawings.
 2. Manufacturers:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817, www.daytonsuperior.com/DurOWal-main.html.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner, <http://www.heckmannbuildingprods.com/>.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner, www.h-b.com.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner, www.wirebond.com.



e. Approved equal.

G. Masonry Cleaners:

1. Proprietary Acidic Cleaner:

- a. Provide the manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces.
- b. Provide a product expressly approved for the intended use by the cleaner manufacturer and the manufacturer of the masonry units being cleaned.

c. Manufacturers:

- 1) Diedrich Technologies, Inc., 202 New Masonry Detergent, www.diedrichtechnologies.com.
- 2) EaCo Chem, Inc.
- 3) ProSoCo, Inc., Sure Klean No. 600 Detergent, www.prosoco.com.
- 4) Approved equal.

2. For masonry not subject to metallic oxidation stains, provide a formulation consisting of a concentrated blend of surface-acting acids, and chelating and wetting agents.

a. Manufacturers:

- 1) Diedrich Technologies, Inc., 202 New Masonry Detergent, www.diedrichtechnologies.com.
- 2) ProSoCo, Inc., Sure Klean No. 600 Detergent, www.prosoco.com.
- 3) Approved equal.

H. Through-Penetration Firestopping Systems:

1. Provide through-penetration firestopping systems complying with the requirements specified in Section 07850, Through-Penetration Firestopping Systems.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. During the period when unit masonry units are being manufactured, the Testing and Inspection Agency and the code-required Approved Agency may perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
2. Tests:
 - a. The unit masonry unit manufacturer must demonstrate the following quality control tests are performed as required in accordance with the specified codes and standards by submitting test reports documenting compliance with the following tests:
 - b. Concrete Masonry Unit Test:



- 1) Test Procedure:
 - a) Each type of concrete masonry unit required will be tested in accordance with the methods specified in ASTM C 140 and Chapter 21 of the Phoenix Building Construction Code and Amendments.
- 2) Acceptance Criteria:
 - a) Concrete masonry units complying with the criteria listed in Table 2105.2.2.1.2 of the Phoenix Building Construction Code and Amendments passes the Concrete Masonry Unit Test.
- c. Test Reports:
 - 1) Submit test reports for each type of masonry unit required to the Program/Project Manager for approval.
 - a) Include size-variation data for the units, verifying that the actual range of sizes falls within the specified tolerances.
 - b) Include test results, measurements, and calculations establishing the net-area compressive strength of the masonry units.
3. Inspections:
 - a. The Program/Project Manager or Approved Agency may place an Inspector in the unit masonry unit manufacturing plant when the units provided under this Section are being manufactured.
- B. Non-Conforming Work:
 1. Retests of materials failing to comply with the specified requirements may be required to be performed at the Contractor's expense.
- C. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when grout or mortar for this Contract are being mixed and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine field conditions for compliance with for installation tolerance requirements and other conditions affecting performance with the installer present.
 - a. Prepare a written field report, endorsed by the installer, listing conditions found that may be detrimental to the performance of the unit masonry assemblies for the record, and submit this installer's field report to the Program/Project Manager for information.
 - b. Verify that foundations are within the tolerances specified.



- c. Verify that reinforcing dowels are properly placed.
 2. Before installation, examine rough-in and built-in construction to verify the actual locations.
- B. Pre-Installation Testing:
 1. Test cleaning methods on a sample wall panel before proceeding to clean production masonry.
 - a. Clean 1/2 of the sample wall panel, and leave one-half of the panel un-cleaned for comparison purposes
 - b. Obtain the Program/Project Manager's approval of the sample cleaning before proceeding to clean production masonry.
- C. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent non-masonry surfaces from contact with masonry cleaner by covering them with a liquid strippable masking agent or polyethylene film and waterproof masking tape.
- B. Surface Preparation:
 1. Keep concrete masonry units and clay tile units dry.
 - a. Do not wet units immediately before or during placement.
 2. Wet those brick having absorption rates in excess of 20 grams per 30 square inches per minute as determined per ASTM C 67 so that the rate of moisture absorption when the bricks are laid does not exceed the permissible amount.
 - a. The brick surface must be dry to the touch when laid.

3.03 INSTALLATION

- A. Provide reinforced cavity and composite walls and other reinforced masonry construction built to the full thickness shown on the Contract Drawings.
 1. Provide single wythe walls of the actual masonry unit widths, using units of the widths indicated.
 2. Reinforce all masonry Work.
 - a. Unless otherwise indicated on the Contract Drawings, place masonry in a running bond.
 3. Align reinforced cells, withes, and voids vertically; and size them so grout pours can be placed and consolidated with a low velocity mechanical vibrator having a 3/4-inch head.
 4. Grout retaining walls and walls below ground solidly with grout.
- B. Masonry Coursing:



1. Maintain masonry courses at a uniform dimension.
 2. Form vertical and horizontal joints of uniform thickness.
 3. Establish the lines, levels, and coursing indicated on the Contract Drawings.
 4. Protect established lines, levels, and coursing from displacement.
- C. Where possible, install full-size units without cutting.
1. Cut units as required to provide a continuous pattern and to fit adjoining construction.
 - a. Furnish motor-driven saws for cutting masonry units that provide clean, sharp, un-chipped edges.
 - b. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified.
 2. Install cut units with the cut surfaces and, where possible, the cut edges concealed.
- D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.
 2. Where the brick is exposed, provide face brick unless otherwise indicated.
- E. Special Techniques:
1. Laying Masonry Walls:
 - a. Unless otherwise shown on the Contract Drawings, lay out reinforced masonry walls in advance to accurately space surface running bond patterns with uniform joint thicknesses, and to accurately locate openings, movement-type joints, returns, and offsets.
 - 1) Avoid providing less-than-half-size units, particularly at corners, jambs, and wherever possible at other locations where vertical wall reinforcement is required.
 - b. Bond Pattern for Exposed Masonry:
 - 1) Unless otherwise indicated in the Contract Documents, lay exposed masonry in a running bond pattern unless otherwise indicated on the Contract Drawings, but do not use units with less than nominal 8-inch (200mm) horizontal face dimensions at corners, jambs, and other locations where vertical wall reinforcement is required.
 - c. Bond Pattern for Concealed Masonry:
 - 1) For concealed masonry, lay all units in a wythe in a running bond or bonded by lapping not less 1/4 of the unit length.
 - a) At corners, bond and interlock each course of each wythe.
 - b) At corners, jambs, and other locations where vertical wall reinforcement is required, do not use units with less than nominal 8-inch (200mm) horizontal face dimensions.
 - d. Stopping and Resuming Work:
 - 1) In each course, stop work by racking back one-half-unit length for one-half running bond, or one-third-unit length for one-third



- running bond, from those in the course below except where horizontal lap splices are required in the horizontal bond beam reinforcement or the horizontal joint reinforcement.
- a) Do not tooth the masonry at stopping points.
 - 2) When resuming work, clean the exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
 - e. Built-in Work:
 - 1) As construction progresses, build in items specified under this and other Sections of the Specifications.
 - 2) Fill in solidly with masonry around built-in items.
 - 3) Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 4) Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
 - f. Under bearing plates, beams, lintels, posts, and similar items, fill cores in hollow concrete masonry units with grout 24 inches (600mm) unless otherwise indicated.
2. Mortar Bedding and Jointing:
- a. Lay hollow masonry units as follows:
 - 1) On horizontal and vertical face shells, provide full mortar coverage.
 - a) Bed the face shells fully in mortar so the head joint depth equals the depth of the bed joints.
 - 2) In the starting course on footings, and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout, bed the webs in mortar.
 - a) Bed the webs of all courses for piers, columns, and pilasters fully in mortar.
 - b) Bed the webs of grouted masonry, including the starting course on footings, fully in mortar.
 - 3) For the starting course on footings where cells are not grouted, spread out a full mortar bed, including the areas under cells.
 - b. Lay solid masonry units with completely filled bed and head joints.
 - 1) Butter the ends with sufficient mortar to fill the head joints, and shove the unit into place.
 - 2) Do not deeply furrow the bed joints or slush the head joints.
 - c. Unless otherwise indicated in the Contract Documents, furnish a jointer larger than the joint thickness; and tool exposed joints to be slightly concave when thumbprint hard.
 - d. For masonry walls to receive plaster or other direct-applied finishes other than paint, cut joints flush unless otherwise indicated.
3. Masonry Joint Reinforcement:
- a. Provide continuous horizontal masonry joint reinforcement as indicated on the Contract Drawings.



- 1) Install the entire length of longitudinal side rods in mortar, with a minimum cover of 5/8 inch (16mm) on the exterior side of the walls, and 1/2 inch (13mm) elsewhere.
 - 2) Lap joint reinforcement a minimum of 12 inches (300mm), with at least one cross wire of each piece of reinforcement in the lap.
 - 3) Space joint reinforcement not more than 16 inches (406mm) apart on center.
- b. Provide reinforcement not more than 8 inches above and below wall openings, and extend the reinforcement 12 inches beyond the openings.
- c. At control and expansion joints, cut or interrupt joint reinforcement unless otherwise indicated in the Contract Documents.
- d. To ensure continuity at corners and wall intersections, provide prefabricated "L" and "T" sections.
- e. To ensure continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions, cut and bend reinforcing units as directed by the manufacturer
4. Control and Expansion Joints:
 - a. Install control and expansion joints in unit masonry where indicated on the Contract Drawings.
 - 1) Build-in related items as masonry progresses.
 - b. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
 - c. Form control joints in concrete masonry by installing preformed control-joint gaskets designed to fit a standard sash block.
 - d. At control joints, do not cut the horizontal bond beam reinforcement at the floor and roof line.
 - 1) Comply with the requirements of special control joint details shown on the Contract Drawings.
 - e. Form expansion joints in brick made from clay by building compressible joint fillers in where indicated in the Contract Documents.
 - f. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of the width required for installing the sealant and backer rod specified in Section 07920, Joint Sealants; but not less than 3/8 inch.
 - 1) Provide horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
5. Installing Glass Block with Mortar
 - a. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.



- b. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain $\frac{1}{4}$ inch exposed joint widths unless otherwise indicated.
 - c. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:
 - 1) Vertical Spacing of Panel Reinforcement for Exterior Panels:
Every other course but not more than 16 inches o.c. starting with first course above sill
 - 2) Do not bridge expansion joints with panel reinforcement.
 - 3) Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
 - 4) Lap panel reinforcement not less than 6 inches if more than one length is necessary.
 - d. Use plastic spacers for temporary wedges in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.
 - e. Keep expansion joints free of mortar.
 - f. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.
 - g. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than $\frac{3}{8}$ inch (10 mm) thick. Compact each layer thoroughly and allow become thumbprint hard before applying next layer. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.
6. Anchoring Masonry Veneer:
- a. Anchor masonry veneers to wall framing and concrete masonry backup with seismic masonry-veneer anchors in accordance with the following requirements:
 - 1) Fasten seismic anchors through sheathing to the wall framing and to concrete masonry backup using metal fasteners of type indicated in the Contract Documents.
 - a) Provide 2 fasteners unless the anchor design only requires 1 fastener.
 - 2) Embed connector sections and continuous wire in masonry joints.
 - a) Provide not less than 2 inches of air space between the back of the masonry veneer and the face of sheathing.
 - 3) Locate the anchor sections to allow the maximum vertical differential movement of the ties up and down.
 - 4) Space the anchors as indicated in the Contract Documents, but not more than 16 inches apart on center vertically and 24 inches apart on center horizontally, and with not less than 1 anchor for each 2.67 square feet of wall area.
 - a) Provide additional anchors within 12 inches of openings and at intervals around perimeter not exceeding 36 inches.



7. Lintels:
 - a. Provide steel lintels where indicated on the Contract Drawings.
 - b. Provide masonry lintels where shown on the Contract Drawings and where openings of more than 24 inches (610mm) for block-size units are shown without structural steel or other supporting lintels.
 - 1) Provide built-in-place masonry lintels.
 - 2) Provide specially formed bond beam units with reinforcing bars placed as indicated and filled with grout.
 - 3) Temporarily support built-in-place lintels until they have cured.
 - c. Unless otherwise indicated in the Contract Documents, provide a minimum bearing of 16 inches (400mm) at each jamb.
 - d. At door jambs where security control devices are required, provide an additional 8-inches of vertically reinforced block cell at each jamb.
8. Flashing, Weep Holes, Cavity Drainage, and Vents:
 - a. Provide embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in walls, and where indicated on the Contract Drawings.
 - 1) Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated on the Contract Drawings.
 - b. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing.
 - 1) Unless otherwise indicated in the Contract Documents, place through-wall flashing on a sloping bed of mortar, and cover it with mortar.
 - 2) Before covering through-wall flashing with mortar, seal penetrations in the flashing with adhesive, sealant, or tape as recommended by the flashing manufacturer.
 - c. Install flashing as follows:
 - 1) At masonry-veneer walls, extend flashing through the veneer, across the air space behind the veneer, and up the face of the sheathing at least 8 inches; with the upper edge tucked under building paper or building wrap, and lapping at least 4 inches.
 - 2) At lintels and shelf angles, extend flashing a minimum of 4 inches (100 mm) into masonry at each end.
 - 3) At heads and sills, extend flashing 4 inches (100 mm) at the ends, and turn the flashing up not less than 2 inches (50mm) to form a pan.
 - 4) Beneath flexible flashing at the exterior face of a wall, install metal drip edges.
 - a) Stop the flexible flashing 1/2 inch back from the outside face of the wall, and adhere the flexible flashing to the top of the metal drip edge.
 - 5) Beneath flexible flashing at the exterior face of a wall, install metal flashing termination.



- a) Stop the flexible flashing 1/2 inch back from the outside face of the wall, and adhere the flexible flashing to the top of the metal flashing termination.
 - 6) After masonry wall construction is completed, cut the flexible flashing off flush with the face of the wall.
 - d. Provide weep holes in the head joints in the exterior wythes of the first course of masonry immediately above embedded flashing, and as follows:
 - 1) Use round plastic tubing to form weep holes.
 - 2) Space weep holes formed from the plastic tubing 16 inches (400 mm) apart on center.
 - e. Place cavity drainage material immediately above the flashing in cavities.
 - f. In exterior wythes, provide vents in the head joints at the spacing indicated on the Contract Drawings, formed using the specified weep/vent products.
 - g. Provide reglets and nailers for flashing and other related construction where they are shown to be built into the masonry on the Contract Drawings.
9. Reinforced Unit Masonry Installation:
- a. Temporary Formwork and Shores:
 - 1) Provide formwork and shores to support reinforced masonry elements during construction.
 - 2) Construct formwork conforming to the shape, line, and dimensions shown on the Contract Drawings.
 - a) Make the formwork sufficiently tight to prevent leakage of mortar and grout.
 - b) Brace, tie, and support the forms to maintain its position and shape during the construction and curing of reinforced masonry.
 - 3) Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
 - b. Placing Reinforcement:
 - 1) Place reinforcement in accordance with the requirements specified in ACI 530/ASCE 5/TMS 402.
 - c. Grouting:
 - 1) Do not place grout until the entire height of masonry to be grouted has attained sufficient strength to resist the grout pressure.
 - 2) For cleanouts and for grout placement, comply with the requirements specified in ACI 530/ASCE 5/TMS 402, including the requirements for minimum grout space and maximum pour height.
 - 3) Do not lay masonry block on a freshly grouted wall within 12 hours of grout placement.



F. Interface with Other Work:

1. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.
2. Leave openings for equipment to be installed before completing masonry.
 - a. After installing equipment, complete the masonry to match the construction immediately adjacent to the opening.

G. Tolerances:

1. Comply with the tolerances specified in ACI 530.1/ASCE 6/TMS 602, and the following tolerances:
 - a. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3mm in 3m), 1/4 inch in 20 feet, or 1/2 inch (12mm) maximum.
 - b. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6mm in 6m), or 1/2 inch (12mm) maximum.
 - c. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3mm in 3m), 1/4 inch in 20 feet, or 1/2 inch (12mm) maximum.
 - d. For exposed bed joints, do not vary from the thickness indicated by more than plus or minus 1/8 inch (3mm), with a maximum thickness limited to 1/2 inch (12 mm).
 - 1) Do not vary from the bed-joint thickness of adjacent courses by more than 1/8 inch (3mm).
 - e. For exposed head joints, do not vary from the thickness indicated by more than plus or minus 1/8 inch (3mm).
 - 1) Do not vary from the adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3mm).
 - f. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of the masonry units within the tolerances specified for the warpage of units.
 - g. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.04 REPAIR/RESTORATION

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units.
1. Install new units to match the adjoining units.
 2. Install the new units in fresh mortar, and point the joints to eliminate evidence the damaged or mismatched units have been replaced.
- B. Pointing:



1. During the tooling of joints, enlarge voids and holes, except for weep holes, and completely fill these voids and holes with mortar.
2. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance.
3. Prepare joints for sealant application where indicated on the Contract Drawings.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when unit masonry units are being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Retests of materials failing to comply with the specified requirements will be performed at the Contractor's expense.
2. Mortar Test:
 - a. Test Procedure:
 - 1) For each mortar mix provided, mortar tests will be performed for each 2500 square feet (232m²) of wall area or portion thereof using the mortar mix.
 - 2) The mortar properties will be tested in accordance with the requirements specified in ASTM C 780.
 - b. Acceptance Criteria:
 - 1) Mortar complying with the compressive strength, water retention, and air content requirements specified in ASTM C 270 or ASTM C 1329 for Type S mortar, passes the Mortar Test.
3. Grout Test:
 - a. Test Procedure:
 - 1) For each day of grout placement at each location within each structure, grout tests will be performed.
 - 2) The compressive strength of the grout will be sampled and tested in accordance with the requirements specified in ASTM C 1019.
 - 3) The slump of the grout will be tested in accordance with the requirements specified in ASTM C 143/C 143M.
 - b. Acceptance Criteria:
 - 1) Grout having at least the compressive strength indicated on the Contract Drawings, and the slump specified herein, passes the Grout Test.
4. Concrete Masonry Prism Test:
 - a. Test Procedure:
 - 1) For each type of concrete masonry unit provided, concrete masonry prism tests will be performed for each 5000 square feet



- (465m²) of concrete masonry unit wall area or portion thereof using that type of concrete masonry unit.
- 2) Each type of concrete masonry unit indicated will be tested in accordance with the requirements specified in ASTM C 1314.
 - b. Acceptance Criteria:
 - 1) Concrete masonry units represented by prisms having the minimum F'm compressive strength for the weight classification and size (width) indicated on the Contract Drawings pass the Concrete Masonry Prism Test.
 5. Inspections:
 - a. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 - b. Place grout only after inspectors have verified compliance of the grout spaces and grades, sizes, and locations of reinforcement.
 - B. Non-Conforming Work
 1. Defective Units:
 - a. Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances, and to contain chips, cracks, or other defects exceeding the limits stated in the standard.
 - b. Do not use units where such defects, including dimensions that vary from the specified dimensions by more than the stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

3.06 CLEANING

- A. In-Progress Cleaning:
 1. Clean unit masonry as the Work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning:
 1. After mortar is thoroughly set and cured, clean exposed masonry by removing large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Wet wall surfaces with water before applying cleaners.
 3. Clean concrete masonry by using the cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
 - a. Clean masonry using a proprietary acidic cleaner applied according to the cleaner manufacturer's written instructions.
 4. Remove cleaners promptly by rinsing surfaces thoroughly with clear water.
- C. Protect all sash, metal items, and other corrodible parts of the structure when masonry is cleaned with corrosive solutions.
- D. Waste Management:



1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
2. Salvageable Materials:
 - a. Unless otherwise indicated, excess masonry materials are considered to be the Contractor's property.
 - b. At completion of unit masonry work, remove salvageable materials from the Site.
3. Excess Masonry Waste:
 - a. Remove excess clean masonry waste that cannot be used as fill and other masonry waste, and place this material in the appropriate container noted in the Waste Management Plan.

3.07 PROTECTION

A. Stain Prevention:

1. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted.
 - a. Immediately remove grout, mortar, and soil that come in contact with such masonry.
2. Protect the bases of walls from rain-splashed mud and from mortar splatter by coverings spread on the ground and over the wall surface.
3. Protect sills, ledges, and projections from mortar droppings.
4. Protect the surfaces of window and door frames, and similar products with painted and integral finishes, from mortar droppings.
5. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

B. Masonry Protection:

1. During the installation of masonry work, provide temporary bracing.
 - a. Maintain the temporary bracing in place until the building structure provides permanent bracing.
2. During construction, cover the tops of walls, projections, and sills with waterproof sheeting at end of each day's work.
 - a. Extend the cover a minimum of 24 inches (600mm) down both sides of the masonry, and hold the cover securely in place.
 - b. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure the cover a minimum of 24 inches down the face next to the unconstructed wythe, and hold cover securely in place.
3. Cover partially completed masonry when construction is not in progress.
4. Without damaging the completed work, provide protective boards at exposed external corners which are subject to damage by construction activities.

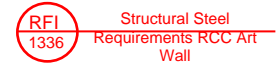
END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.1, 1.02, 1.04B, 2.01.D, 2.01.D.4	Add requirements for ENVISION Sustainability Rating System



SECTION 05120



STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the design, fabrication, and installation of structural metal framing.
 - a. For architecturally exposed structural steel, refer to Section 05121, Architecturally Exposed Structural Steel.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 03600 - Grouts.
 - 4. Section 05121 - Architecturally Exposed Structural Steel.
 - 5. Section 05310 - Steel Deck.
 - 6. Section 07810 - Applied Fireproofing.
 - 7. Section 09960 - High-Performance Coatings.
 - 8. Section 09967 - Intumescent Paints.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AESS: Architecturally Exposed Structural Steel.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO HB-17 - Standard Specifications for Highway Bridges.
 - 2. American Concrete Institute (ACI):



- a. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary.
3. American Galvanizers Association (AGA):
 - a. Quality Assurance Manual.
 - b. Recommended Details for Hot-Dip Galvanized Structures.
 - c. The Design of Products to be Hot-Dip Galvanized after Fabrication.
 - d. The Inspection of Hot-Dip Galvanized Steel Products.
4. American Institute of Steel Construction (AISC):
 - a. AISC 201 - Certification Program for Structural Steel Fabricators.
 - b. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
 - c. ANSI/AISC 360 – Specification for Structural Steel Buildings.
5. American Welding Society (AWS):
 - a. ANSI/AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - b. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - c. AWS D1.5/D1.5M - Bridge Welding Code.
 - d. AWS WZC – Welding Zinc-Coated Steels (D19.0).
6. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM A 108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
 - d. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - e. ASTM A 143/A 143M - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - f. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - g. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - h. ASTM A 384/A 384M - Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - i. ASTM A 385 - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - j. ASTM A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 - k. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - l. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
 - m. ASTM A 572/A 572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.



- n. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- o. ASTM A 992/A 992M - Standard Specification for Structural Steel Shapes.
- p. ASTM B 6 - Standard Specification for Zinc.
- q. ASTM D 6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- r. ASTM E 164 - Standard Practice for Ultrasonic Contact Examination of Weldments.
- s. ASTM E 376 - Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods.
- t. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
- u. ASTM F 436 - Standard Specification for Hardened Steel Washers.
- v. ASTM F 959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
- w. ASTM F 1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- x. ASTM F 1852 - Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- 7. Canadian Standards Association (CSA):
 - a. CAN/CSA G164-M92 – Hot Dip Galvanizing of Irregularly Shaped Articles.
- 8. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 9. Green Seal, Inc. (GS):
 - a. GC-03 - Green Seal™ Environmental Criteria for Anti-Corrosive Paints.
 - b. GS-11 – Green Seal™ Environmental Standard for Paints and Coatings.
- 10. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. ICC-ES Evaluation Reports, http://www.icc-es.org/Evaluation_Reports/index.shtml.
- 11. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Automated Train Facilities Design Criteria.
- 12. Research Council on Structural Connections of the Engineering Foundation (RCSC):
 - a. RCSC Specification for Structural Joints Using High Strength Bolts.
- 13. State of Arizona:
 - a. Arizona Department of Transportation (ADOT):
 - 1) ADOT Bridge Practice Guidelines.



- 2) ADOT Standard Specifications for Road and Bridge Construction.
- 14. The Society for Protective Coatings (SSPC):
 - a. SSPC Painting Manual.
 - 1) SSPC-SP 3 - Surface Preparation Specification No. 3 Power Tool Cleaning.
 - 2) SSPC-SP 6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
 - 3) SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
- 15. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 - Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 - Safety and Health Regulations for Construction.
- 16. Institute for Sustainable Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. 10 days before structural steel is to be erected, give notice to those performing other construction work related to the steel erection, such as to those performing work that must be supported by or that will provide support of the steel, to allow such items to be introduced or furnished before the steel is erected.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- B. Sequencing:
 - 1. Sequence the erection of structural steel to follow construction of supporting concrete and masonry load bearing walls and concrete foundations.
- C. Scheduling:
 - 1. Coordinate the structural steel fabrication schedule with the progress of the Work so delays are avoided.



- a. Ensure materials are delivered to the Site in quantities and at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- b. Deliver anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time so that the Work is not delayed.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Structural steel.
- 2) High-strength bolted connections fasteners.
- 3) Anchor rods.
- 4) Bolt lubricant.
- 5) Expansion anchors.
- 6) Adhesive anchors.
- 7) Welding electrodes.
- 8) Primer.
- 9) Post-Industrial Recycled Content Affidavit.
- 10) Post-Consumer Recycled Content Affidavit.

b. Shop Drawings:

- 1) Standard details.
- 2) Structural detail drawings.
- 3) Galvanized member drawings.
- 4) Working Drawings.

c. Certificates:

- 1) Structural steel mill test reports.
- 2) Manufacturer's Certification of Fastener Components.
- 3) Hot-Dip Galvanizing Certificate of Compliance.

d. Qualification Statements:

- 1) Welding procedure specifications (WPS) test records.
- 2) Welding Certificates.
- 3) Structural steel fabricator qualifications.
- 4) Hot-dip galvanizing plant's qualifications.
- 5) Structural steel erector qualifications.
- 6) Professional Land Surveyor's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Materials



- 1) Submit product data for recycled content indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

C. Closeout Submittals:

1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Manufacturer's Instructions:
 - 1) Adhesive manufacturer's recommendations.
 - b. Site Quality Control Submittals:
 - 1) Professional Land Surveyor survey of the locations of the top of steel elevations and the edge of slab locations.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Recycled Steel:
 - a. Provide steel with the following percentages of recycled steel:
 - 1) Post-industrial recycled content: 90 percent, minimum.
 - 2) Post-consumer recycled content: 75 percent, minimum.
 - b. Submit written affidavits from the steel manufacturer verifying that the recycled steel content provided complies with the specified requirements.
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):



- 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.5/D1.5M, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in the following:
 - a) For station and building connection applications, the qualification tests prescribed in AWS D1.1/D1.1M.
 - b) For guideway members and guideway supporting steel structures, the qualification tests prescribed in AWS D1.5/D1.5M.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
2. Structural Steel Fabricator's Qualifications:
 - a. Employ a structural steel fabricator experienced in fabricating structural steel similar to that indicated for this Contract.
 - 1) The fabricator chosen must participate in the AISC Certification Program described in AISC 201, and must be designated an AISC Certified Plant, Category BU.
 - 2) Use a structural steel fabricator exhibiting a minimum of 5 continuous years of successful in-service performance.
 - b. Employ a structural steel fabricator having sufficient production capacity to produce and deliver the materials in time to meet the approved construction schedule for this Contract.
 - c. Submit the structural steel fabricator's qualifications to the Program/Project Manager for approval.
3. Hot-Dip Galvanizing Plant's Qualifications:



- a. Employ a firm that is a member of the American Galvanizers Association (AGA) with a hot-dip galvanizing plant for performing galvanizing operations for this Contract.
 - b. Submit a letter on company letter head giving the location of the plant proposed for performing the galvanizing operations and stating the number of years of experience the galvanizing plant has had performing work similar to that required under this Contract to the Program/Project Manager for approval.
 - 4. Structural Steel Erector's Qualifications:
 - a. Employ a structural steel erector experienced in erecting structural steel work similar to that required for this Contract who has a minimum of 5 continuous years of providing successful in-service performance.
 - b. Submit the structural steel erector's qualifications to the Program/Project Manager for approval.
 - 5. Professional Land Surveyor's Qualifications:
 - a. Employ an independent Professional Land Surveyor, registered in the State of Arizona, who is qualified to perform the survey work required under this Section.
 - b. Submit the Professional Land Surveyor's qualifications to the Program/Project Manager for approval.
- C. Certifications:
- 1. Mill Test Reports:
 - a. Submit structural steel mill test reports, signed by the manufacturer of the structural steel products, certifying the products provided comply with the specified requirements.
 - 1) Certify the material provided conforms to the appropriate ASTM specification.
 - 2) For the rolled steel sections, girders, and steel plates for primary and secondary guideway support members, provide Charpy V-notch (CVN) impact test values in accordance with the requirements specified in Subsection 604-2.01 of the ADOT Standard Specifications for Road and Bridge Construction.
 - 2. Manufacturer's Certification of Fastener Components:
 - a. For each type and size of fastener component and each fastener assembly item, submit the manufacturer's certification documents and test reports required by the Specifications, Code, or ASTM procedures.
 - b. For each lot of bolts, nuts, and washers for primary and secondary guideway support members, submit a Certificate of Analysis complying with the requirements specified in Subsection 604-2.03(A) of the ADOT Standard Specifications for Road and Bridge Construction.
 - 3. Hot-Dip Galvanizing Certificate of Compliance:
 - a. For the hot-dip galvanized components provided, submit the original and 2 copies of a Certificate of Compliance from the coating



applicator, signed by the galvanizer and notarized, certifying that the hot-dip galvanized coatings meet or exceed the requirements specified in ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable.

- 1) Certify that samples representing each lot have been tested and inspected in accordance with the requirements of ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable.
 - a) Include a report containing the test results supporting the certification.
- 2) Include a detailed description of the material processed and indicate which ASTM standard applies to the coating provided.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Use special care in shipping structural steel members.
2. Ship small parts, such as bolts, nuts, washers, pins, fillers, and small connecting plates and anchors, in boxes, crates, or barrels.
 - a. Pack each length and diameter of bolt and each size of nut and washer separately.
 - b. Plainly mark an itemized list and description of the contents on the outside of each container.

B. Storage and Handling Requirements:

1. Use special care in handling structural steel members.
2. Store structural steel on platforms, skids, blocking, or other supports to prevent contact with dirt, debris, and moisture.
 - a. Store beams with webs vertically.
 - b. Protect structural steel from exposure to conditions that produce rust.
3. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
4. Handle structural steel so no parts are bent, broken, or otherwise damaged; and avoid damage to other material and work.
 - a. Exercise care to avoid scraping and over stressing the steelwork.
 - b. Replace bent or damaged pieces, unless the Program/Project Manager authorizes repairs.

PART 2 PRODUCTS

2.01 STRUCTURAL STEEL SYSTEMS

A. Manufacturers:

1. Manufacturer List:



- a. The structural steel fabricator must participate in the AISC Certification Program described in AISC 201, and must be designated an AISC Certified Plant, Category BU.
 - 1) The American Institute of Steel Construction (AISC) maintains a current list of AISC Quality Certified Fabricators at <http://www.aisc.org/find/FindCertifiedCompany.aspx?id=5542>.
- b. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. No substitutions for an AISC Quality Certified Fabricator is allowed for this Contract.
 - b. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
3. Product Options:
 - a. Submit the manufacturer's Product Data for each type of product indicated and provided to the Program/Project Manager for approval.
- B. Regulatory Requirements
 1. Erect structural steel in compliance with the requirements of 29 CFR 1910 and 29 CFR 1926, particularly 29 CFR 1926.754, Structural Steel Assembly, 29 CFR 1926.755, Column Anchorage, and 29 CFR 1926.756, Beams and Columns, and with the requirements of ICC International Building Code (IBC) as Amended by the City of Phoenix.
- C. ENVISION Requirements:
 1. Recycled Content
 - a. Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
 2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.
- D. Design Criteria:
 1. The structural steel and connection details shown on the Contract Drawings have been designed in compliance with the applicable requirements of the American Association of State Highway and Transportation Officials (AASHTO), American Institute of Steel Construction (AISC), Arizona Department of Transportation (ADOT), American Welding Society (AWS), ASTM International (ASTM), Phoenix Sky Harbor International Airport (PSHIA), Research Council on Structural Connections (RCSC), and SSPC The Society for Protective Coatings (SSPC), standards listed in Paragraph 1.02.B.
 2. Shop Drawings:



- a. Standard Details:
 - 1) Prior to submitting detailed Shop Drawings for the structures, submit the standard details for typical beam, girder, and column splices, and for moment connection details to the Program/Project Manager for approval.
 - 2) Use the type of shop and field connections shown on the Contract Drawings.
 - a) If no type is shown, use the most appropriate type.
 - b) One-sided or other eccentric connections are not permitted unless detailed on the Contract Drawings.
 - b. Structural Details:
 - 1) Submit Shop Drawings, sealed and signed by a Professional Engineer licensed in the State of Arizona, that identify the structural details as shown on the Contract Drawings, and completely indicate the location of the structural details within the Work of the Contract.
 - a) Indicate the size, weight, and quantities of members; the methods of joining various components; finishes; the location and type of anchors; and necessary dimensions.
 - b) Use the standard welding symbols specified in ANSI/AWS A2.4 on the Shop Drawings showing the size, length, and type of each weld.
 - c) Note variations in tolerances or clearances between various products on the Shop Drawings.
 - d) For shop assemblies that require markings to facilitate identification during erection, provide easy-to-read markings on the Shop Drawings and erection drawings.
 - c. Galvanized Member Shop Drawings:
 - 1) Submit Shop Drawings of the galvanized members showing the lifting/handling lugs for both the galvanizing process and for erection of the members, and list the type of nylon straps/chokers or other lifting aids to be used so the galvanized coatings will not be damaged.
3. Working Drawings:
- a. Submit erection drawings and the setting diagrams, templates, and directions for installing structural framing anchor bolts, bearing plates, and other embedded items.
- E. Materials:
- 1. Steel:
 - a. Provide structural steel meeting the requirements of ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; and ASTM A 992/A 992M as noted on the Contract Drawings.
 - 1) Provide rolled sections, girders, and structural steel plate for the primary and secondary guideway support system complying with



the requirements specified in Section 604 of the ADOT Standard Specifications for Road and Bridge Construction.

- b. For the structural steel types listed below, provide steel meeting the requirements of the standards following that type.
 - 1) Rectangular and Square High Strength Steel (HSS) Tubing: Provide steel meeting the requirements of ASTM A 500, Grade B.
 - 2) Steel Pipe: Provide black steel pipe complying with the requirements specified in ASTM A 53/A 53M.
 - 3) Round High Strength Steel (HSS): Provide steel complying with the requirements specified for Grade B steel in ASTM A 500.
 - 4) Steel Bearing Plates for Guideway Bearing Assemblies: Provide steel complying with the requirements specified in ASTM A 36/A 36M.
- 2. Fasteners:
 - a. High-Strength Bolted Connections:
 - 1) High Strength Bolts:
 - a) Provide bolts meeting the requirements of ASTM A 325.
 - 2) Carbon and Alloy Steel Nuts:
 - a) Provide heavy hex nuts meeting the requirements of ASTM A 563.
 - 3) Hardened Steel Washers:
 - a) Provide washers complying with the requirements for Type 1 washers specified in ASTM F 436.
 - 4) Bolts, Nuts and Washers for Guideway Bearing Assemblies:
 - a) For guideway support member connections, provide bolts, nuts and washers complying with the requirements specified in Section 604 of the ADOT Standard Specifications for Road and Bridge Construction, and galvanized in accordance with the requirements specified in ASTM A 153/A 153M.
 - 5) Fastener Assemblies:
 - a) Galvanized high strength bolts and nuts are considered to be a fastener assembly, and the nuts must be lubricated by the Supplier and tested with the high strength bolts furnished.
 - 6) Twist-Off-Type Tension Control Bolt Assemblies:
 - a) For connections not associated with the guideway support system, twist-off-type tension control bolts complying with the requirements specified in ASTM F 1852 may be provided.
 - b. Anchor Rods and Bolts:
 - 1) Rods:
 - a) Provide end-threaded rods complying with the requirements specified for Grades 36, 55, or 105 in ASTM F 1554 as noted on the Contract Drawings.
 - 2) Nuts:



- a) Provide heavy hex nuts complying with the requirements specified in ASTM A 563.
 - 3) Washers:
 - a) Provide washers complying with the requirements specified in ASTM F 436.
 - 4) Anchor Bolts for Guideway Members:
 - a) Provide anchor bolts for bearing assemblies complying with the requirements specified in ASTM A 36/A 36M.
 - c. Bolt Lubricant: Provide bolt lubricant having a molybdenum disulfide base.
 - d. Expansion Anchors:
 - 1) Provide zinc-plated expansion anchors complying with the requirements specified in Appendix D of ACI 318/318R, that have a currently approved ICC-ES Evaluation Report, and having Type 316 stainless steel wedge clips.
 - 2) Manufacturers (and acceptable models):
 - a) Hilti Corporation; Kwik-Bolt TZ, www.hilti.com.
 - b) Simpson Strong Tie, Strong-Bolt, www.strongtie.com.
 - c) Approved equal.
 - e. Adhesive Anchors:
 - 1) Provide adhesive anchors composed of an anchor rod assembly and injection cartridge.
 - a) Provide adhesive anchors complying with the requirements specified in Appendix D of ACI 318/318R, and having a currently approved ICC-ES Evaluation Report.
 - b) For exterior exposed locations, provide only stainless steel adhesive anchor rod assemblies.
 - c) Injection Adhesive:
 - (1) Provide a mixture of resin, hardener, cement, and water that provides optimal curing speed and high strength.
 - (2) Furnish the components in side-by-side refill packs that keep two components separate until use; or alternately furnish the product in large rigid cartridges.
 - 2) Manufacturers (and acceptable models):
 - a) Hilti Corporation; HIT RE 500-SD, www.hilti.com.
 - b) Simpson Strong Tie, XP, www.strongtie.com.
 - c) Approved equal.
- 3. Welding Electrodes:
 - a. For station and building connections, provide welding electrodes complying with the requirements specified for E70XX electrodes in Table 3.1 of AWS D1.1/D1.1M.
 - b. For guideway members, provide welding electrodes complying with the requirements specified in AWS D1.5/D1.5M.
 - c. Provide low-hydrogen electrodes for field welding.
 - 4. Welded Stud Shear Connectors:



- a. For guideway members, provide welded stud shear connectors complying with the requirements specified in Section 604 of the ADOT Standard Specifications for Road and Bridge Construction.
- b. For other than guideway members, provide headed stud type shear connectors (studs) complying with the requirements specified in Section 05310, Steel Deck.

F. Fabrication

1. Shop Fabrication:

- a. Fabricate structural steel in accordance with the Contract Drawings and the referenced AISC standards.
 - 1) For steel associated with the guideway support systems, provide materials complying with the requirements specified in Division 2, Section 11 "Steel Structures" in AASHTO HB-17.
- b. Shearing, Flame Cutting, and Chipping:
 - 1) Perform shearing, flame cutting, and chipping carefully and accurately so residual stress is not induced in the metal being cut.
 - a) Flame-cut the edges of members subjected to dynamic loading either by using a mechanically guided torch or by hand, and remove all nicks.
 - (1) Fabricate the radii of re-entrant gas-cut fillets as large as practicable, but in no case less than 3/4 inch.
 - (2) Perform flame cutting so the metal being cut is not carrying stress.
 - (3) Finish the exposed edges of members that were flame-cut by hand by grinding.
 - b) Add additional reinforcing as required where members are cut or coped to meet framing conditions.
- c. Bolt Holes:
 - 1) Punch, drill, subpunch, subdrill, or ream holes for bolts as required in accordance with the requirements specified in the following:
 - a) For station and building connections, in ANSI/AISC 360.
 - b) For guideway support structure connections, in Division 2, Section 11 "Steel Structures" in AASHTO HB-17.
- d. Holes for Other Work:
 - 1) Provide holes required for securing other work to structural steel framing and for passage of other work through members as shown on the final approved Shop Drawings.
 - a) Ream, drill, or punch holes perpendicular to the metal surface.
 - b) Do not flame cut holes or enlarge them by burning.
 - 2) Do not make additional openings in members not shown on the final approved Shop Drawings unless approval to do so is received from the Program/Project Manager.



- e. Mill the ends of columns and other members that will transmit loads in bearing.
- f. Except where welded connections are shown, for shop connections use bolts complying with the requirements specified in ASTM A 325.
 - 1) Install and tighten high strength bolts in accordance with the requirements of the RCSC Specification for Structural Joints Using High Strength Bolts.
 - 2) Arrange the bolts as indicated on the Contract Drawings; or if not indicated, arrange the bolts so that heads show in areas exposed to view.
 - 3) Clearly indicate the bolt arrangements on Shop Drawing submittals.
- g. Welding:
 - 1) Perform welding in accordance with AWS D1.1/D1.1M, except as modified herein.
 - 2) Use a welding procedure and sequence of welding that minimizes stresses and prevents needless distortion.
 - a) If it is necessary to straighten transverse warpage of flanges, use controlled heating along the outside face.
 - b) Allow for expected weld shrinkage when laying out and assembling members in the shop.
 - c) Trim members to size only when most or all of welding has been completed.
 - 3) On Architectural Exposed Structural Steel (AESS), prevent surface bleeding of back-side welding.
 - a) Provide continuous welds of uniform size and profile.
 - b) Grind butt welds flush.
 - c) Dress exposed welds.
 - 4) Weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure.
 - a) For guideway support steel, perform welding in accordance with the requirements specified in AWS D1.5/D1.5M.
- h. Properly mark and match mark materials to facilitate handling and field assembling components.
 - 1) Mark each member with its weight.
 - 2) Match-mark all shop pre-fitted members.

G. Finishes:

1. Primer Materials:

- a. ENVISION Requirements: For field applied paints used to touch up shop applied primer, provide paints with no more than 100 g/L of measured VOC content. This requirement does not apply to paints or primers applied to finishes outside of the building envelope.
- b. Provide a two-component fast-curing, low volatile organic compounds (VOC), metallic zinc-rich epoxy primer complying with the requirements specified in SSPC-Paint 20.



- c. Manufacturers:
 - 1) International Protective Coatings, Interzinc 315,
www.international-pc.com.
 - 2) Approved equal.
- 2. Finish Materials:
 - a. For Station and building structures, refer to the requirements specified in Section 07810, Applied Fireproofing, and Section 09960, High-Performance Coatings, for shop and field finish materials required for painted and coated surfaces.
 - b. Below Grade Coating:
 - 1) Where structural steel is to be placed below grade, apply a coal tar epoxy coating to provide a total coating thickness of 20 mils.
- 3. Shop Finishing Methods:
 - a. Unfinished Surfaces on Station and Building Structures:
 - 1) Do not paint the following surfaces of structural steel members:
 - a) Connection plates and members where slip-critical connections are required.
 - b) Surfaces in contact with fireproofing as specified in Section 07810, Applied Fireproofing.
 - c) Surfaces to be encased in concrete, except for the initial 2 inches of the length embedded.
 - d) Top flanges of beams to which metal decking or shear connectors are to be attached.
 - e) Surfaces that are within 0.5 inch of the toe of a weld prior to welding.
 - b. Finished Surfaces:
 - 1) Surface Preparation:
 - a) For station and building structures, clean the surfaces in accordance with the requirements of SSPC-SP 3 Power Tool Cleaning found in the SSPC Painting Manual.
 - b) For guideway support structures, clean steel surfaces in accordance with the requirements specified in Section 610 of the ADOT Standard Specifications for Road and Bridge Construction.
 - 2) Galvanizing:
 - a) For station and building structural steel specified to be galvanized, hot-dip galvanize the steel members and fabrications in accordance with ASTM A 123/A 123M to the thicknesses specified therein.
 - 3) Apply Primer:
 - a) For stations and buildings, immediately after surface preparation of structural steel apply the primer according to the manufacturer's instructions at a rate as recommended in the SSPC Painting Manual to provide a dry film thickness of not less than 1.5 mils.



- b) For guideway support structures, apply prime coats to structural steel in accordance with the requirements specified in Section 610 of the ADOT Standard Specifications for Road and Bridge Construction.
- c) Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
- d) For members to receive intumescent paint, apply a primer compatible with the finish coat specified in Section 09967, Intumescent Paints.
- 4) Apply Finish Coats:
 - a) For stations and buildings, apply finish coats of paint to structural steel in accordance with the requirements specified in Section 09960, High-Performance Coatings.
 - b) For guideway support structures, apply finish coats of paint to structural steel in accordance with the requirements specified in Section 610 of the ADOT Standard Specifications for Road and Bridge Construction.
- c. Cleaning:
 - 1) After structural steel for stations and buildings is fabricated, clean heavy deposits of oil and grease from unpainted structural steel surfaces in accordance with applicable AISC standards.

2.02 ACCESSORIES

A. Grout:

- 1. Provide non-shrink, non-metallic grout as specified in Section 03600, Grouts.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. Materials and fabrication procedures specified in this Section require advance examination or laboratory testing by the code-required Approved Agency for performing Special Inspections and the Testing and Inspection Agency.
 - a. Provide these inspection and testing entities with access to the places where structural steel work is being fabricated or produced so the required inspections and testing can be performed before the material is shipped.
 - b. Both continuous and periodic Special Inspections will be performed during the fabrication of structural steel.
- 2. Material Tests:
 - a. Test Procedure:
 - 1) Material and physical analyses and tests as required by the ASTM Specifications referenced in Subparagraph 1.02.B.6 will be performed, including tests on filler metals for welding, and



- mechanical tests for high-strength threaded fasteners will be performed.
- b. Acceptance Criteria:
 - 1) Materials complying with the requirements of the standards are acceptable.
 - 3. Structural Steel Connection Tests:
 - a. Test Procedure:
 - 1) Shop-bolted structural steel connections will be inspected and tested in accordance with the International Building Code as Amended by the City of Phoenix, the AISC specifications listed in Subparagraph 1.02.B.4, and the RCSC Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts.
 - a) Test and inspect the connections for guideway support members in accordance with the requirements specified in Section 604 of ADOT Standard Specifications for Road and Bridge Construction.
 - 2) For slip-critical and pretension connections, 2 bolts, or 10 percent of the bolts, per connection, whichever is greater, will be tested.
 - b. Acceptance Criteria:
 - 1) The use of proper fastening components will be verified.
 - 2) Proper fabrication of the connected elements will be verified.
 - 4. Shop Welding Tests:
 - a. Test Procedure:
 - 1) Shop-welded connections will be tested in accordance with the requirements of AWS D1.1/D1.1M and the following:
 - a) The entire length of all full penetration welds will be visually inspected and ultrasonically tested in accordance with the requirements of ASTM E 164.
 - b) The entire length of all fillet welds will be visually inspected.
 - c) Fillet welds will be tested in accordance with the requirements for the Magnetic Particle Method specified in ASTM E 709 and the following.
 - (1) For gusset plates welded to steel members, 20 percent of fillet weld locations will be tested.
 - (2) For all other fillet weld locations, a minimum of 5 percent of the welds will be tested.
 - d) Both the type and location of all weld defects found in the work and the work required to correct these deficiencies will be recorded.
 - b. Acceptance Criteria:
 - 1) Perform and record the work to correct the deficiencies discovered.
 - 5. Inspections:
 - a. Shop Welding:



- 1) All welders and welding materials being supplied under this Contract will be verified as properly certified.
 - 2) Shop welds made during fabrication of structural steel assemblies will be inspected by performing a visual inspection of the full length of the welds.
 - 3) Welds of guideway support members will be inspected in accordance with the requirements specified in Section 604 of the ADOT Standard Specifications for Road and Bridge Construction.
- B. Non-Conforming Work:
1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.
 2. Depending on the amount of non-conforming work encountered, the amount of testing required may be modified.
- C. Coordination of Other Tests and Inspections:
1. Notify the code-required Approved Agency responsible for performing special inspections when structural steel for this Contract is being fabricated, shipped, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Before proceeding to erect the structural steel, verify the elevations of concrete and masonry bearing surfaces and the locations of anchorages are in compliance with the Contract Documents and ready to receive the work of this Section.
 2. Ensure anchor rods, bolts, and other embedded items that vary in location from the dimensions shown on the Contract Drawings are positioned within the tolerances listed in AISC 303.
- B. Evaluation and Assessment:
1. Immediately report any errors in the structural steel which will prevent the proper erection and fitting of parts.
 - a. Report errors resulting from either shop fabrication or deformation resulting from handling or transportation.
 2. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation:



1. If anchor rods or bolts were cast in the substructure when it was constructed, ensure they are held firmly in the correct position and at the proper elevation by suitable templates.
2. Install Expansion and Adhesive Anchors:
 - a. Install expansion and adhesive anchors in strict accordance with the manufacturer's instructions and the applicable approved ICC-ES Legacy Report.
 - 1) Drill holes of the required diameter and depth consistent with the anchor manufacturer's installation instructions using a rotary hammer type drill.
 - b. Expansion Anchor Installation:
 - 1) Embed expansion anchors to a minimum embedment of 8 bolt diameters, unless otherwise indicated on the Contract Drawings or in the manufacturer's instructions.
 - c. Adhesive Anchor Installation:
 - 1) Prior to setting the adhesive anchor studs, clean loose material from the drilled holes by first blowing oil-free compressed air from the back of the hole until the air is free of dust, next brush the hole 2 times with a brush having a diameter the same as the borehole, and then blow oil-free compressed air into the hole twice more until the air stream is free of dust.
 - a) Repeat this procedure as needed.
 - b) Comply with additional requirements of the adhesive manufacturer's recommended procedures.
 - c) Ensure the brush is the correct size for each hole, and replace worn out brushes.
 - 2) Cover each cleaned hole until an adhesive anchor is actually installed in it.
 - 3) Embed the anchor rods in adhesive within the holes in accordance with the recommendations of the adhesive manufacturer.
 - a) Embed anchor rods to a minimum embedment of 8 rod diameters, unless otherwise indicated on the Contract Drawings or in the manufacturer's instructions.
 - b) Do not disturb the anchor/dowel until the gel-time has elapsed.
 - c) Do not apply a load/torque to the anchor until the cure time has elapsed.
 - d) Submit the adhesive manufacturer's recommendations regarding adhesive application, gel/cure times, and acceptable environmental conditions such as ambient temperatures.
3. Thoroughly clean surfaces to be joined.



3.03 ERECTION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads.
 - 1. Use temporary bracing to resist loads to which the structures may be subjected, including loads from erection equipment or its operation.
 - 2. Leave temporary bracing in place as long as may be required for safety.
- B. Erect structural steel elements plumb, in the location and at the elevation shown on the Contract Drawings, and in accordance with the match marks, pertinent regulations, and the referenced AISC standards.
 - 1. Align column bases and bearing plates for beams and similar structural members using steel wedges or shims.
 - 2. Do not field cut or alter structural members without the approval of the Program/Project Manager.
 - 3. Allow concrete foundations to cure for a minimum of 14 days before tightening anchor rod hardware.
 - a. Do not tighten anchor rod hardware using impact torque wrenches.
- C. Apply a coal tar epoxy coating to steel below grade.
- D. Bolted Connections:
 - 1. For connections using high-strength steel bolts, comply with the requirements of the referenced AISC Specifications.
 - a. For guideway support member connections comply with the requirements specified in Section 604 of ADOT Standard Specifications for Road and Bridge Construction and with AASHTO HB-17.
 - b. Assemble high-strength bolted parts so they fit solidly together when assembled.
 - 1) Remove scale, dirt, butts, and other defects liable to prevent proper seating when joint surfaces are assembled, particularly joint surfaces adjacent to washers.
 - 2) Do not use gaskets or any other interposed compressible materials.
 - 3) Only use drift pins for bringing members into position, not to enlarge or distort holes.
 - 2. Ensure that holes are not enlarged, and that drifting occurring during assembly does not disturb metal in the vicinity of holes.
 - a. Enlarge holes to admit bolts for connections only if approved by the Program/Project Manager.
 - 1) Make the enlargement by reaming and not by burning.
 - 2) Avoid hand reaming.
 - 3. As erection progresses, install sufficient bolts in the work to resist dead loads, wind loads, and erection loads.



- a. Arrange and insert the bolts so the bolt heads show in areas exposed to view.
 - b. Do not permanently fasten the bolted connections until the structural steel has been sufficiently aligned and bolted to support as much of the structure as possible by such fastening work.
 4. For bearing-type connections, tighten the ASTM A 325 bolts to a snug tight condition by either applying a few impacts from an impact wrench or the full effort of an ironworker using an ordinary spud wrench so all plies of the connected material have been brought into firm contact.
 5. For slip-critical and pretension connections, tighten the ASTM A 325 bolts, nuts, and twist-off-type tension control bolt in accordance with the referenced AISC specifications.
 - a. Clean oil, paint, and lacquer from the contact surfaces of slip-critical joints.
- E. Field Welding:
 1. Field welding is only permitted where approved by the Program/Project Manager, indicated on the Contract Drawings, or indicated in the approved Shop Drawings.
 - a. Securely tighten erection bolts used in welded construction and leave them in place.
 - b. Field welding rigid frame flange connection plates on columns may only be done if required for ease of erection; and if required, must be clearly indicated on the approved Shop Drawings and approved by the Program/Project Manager.
 2. Weld guideway support members in accordance with the requirements specified in Section 604 of the ADOT Standard Specifications for Road and Bridge Construction.
- F. Grouting Bearing Plates:
 1. After the supported members for building structures have been aligned and properly positioned, and the anchor nuts have been tightened, dry-pack the entire area under bearing plates with non-shrink non-metallic grout as indicated on the Contract Drawings.
 2. Do not place concrete on steel structures until the grout is in place and anchor nuts have been tightened.
- G. Interface with Other Work:
 1. Prior to installing metal decking, clean all heavy rust, mill scale, dirt or other material from the unpainted top flanges of supporting beams.

3.04 REPAIR

- A. Immediately after erection, clean field welds, bolted connections, and areas where shop paint is abraded; and prime them with paint of the same quality as that used for the shop coat.



1. For stations and buildings, prime them with paint in accordance with the requirements specified in Section 09960, High-Performance Coatings.
 2. For guideway elements, prime them with paint in accordance with the requirements specified in the ADOT Standard Specifications for Road and Bridge Construction.
- B. Repair galvanized areas damaged by welding and flame cutting, and during handling, transport, and erection.
1. For stations and buildings, use an approved repair method in accordance with the requirements specified in ASTM A 780.
 2. For guideway elements, use an approved repair method in accordance with the requirements specified in ADOT Standard Specifications for Road and Bridge Construction.
- C. Apply touch-up paint to exposed areas.
1. For stations and buildings, use material complying with the requirements specified in Section 09960, High-Performance Coatings.
 2. For guideway elements, use material complying with the requirements specified in ADOT Standard Specifications for Road and Bridge Construction.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
1. During the period when structural steel is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Both continuous and periodic Special Inspections will be performed during the erection of structural steel.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Connection Testing
 - a. Test Procedure:
 - 1) The field-bolted structural steel connections will be inspected and tested in accordance with the AISC specifications listed in



Subparagraph 1.02.B.4, and the RCSC Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts.

- a) Test and inspect the connections for guideway support members in accordance with the requirements specified in Section 604 of ADOT Standard Specifications for Road and Bridge Construction.
 - 2) Use of proper fastening components and proper fabrication of connected elements will be verified.
 - 3) 2 bolts or 10 percent per connection for each slip-critical and pretension connection will be tested.
 - b. Acceptance Criteria:
 - 1) Connections complying with the requirements specified in the AISC and RCSC specifications will be acceptable.
3. Field Welding Testing:
- a. Test Procedure:
 - 1) Field welds made during erection of structural steel assemblies will be inspected and tested, first by having a visual inspection of the full length of all welds performed, and then by having field-welded connections inspected and tested in accordance with the requirements of AWS D1.1/D1.1M and the following:
 - a) For guideway support member connections comply with the requirements specified in Section 604 of ADOT Standard Specifications for Road and Bridge Construction and with AASHTO HB-17.
 - b) Prior to the ultrasonic testing, remove run-off tabs of full penetration welds and grind those areas smooth, then magnetic particle testing (MT) of the ends will be performed.
 - c) The entire length of all full penetration welds will be ultrasonically tested in accordance with the requirements of ASTM E 164.
 - d) The entire length of all fillet welds will be tested in accordance with the requirements for the Magnetic Particle Method specified in ASTM E 709 and the following.
 - (1) For beam connection plates (angles) welded to plates embedded in concrete, all welds will be tested.
 - (2) For diagonal bracing members welded to gusset plates 40 percent of the fillet weld locations will be tested.
 - (3) For gusset plates welded to steel members, 40 percent of the fillet weld locations will be tested.
 - (4) For all other fillet weld locations, a minimum of 10 percent of the welds will be tested.
 - 2) Both the type and location of defects found in the work will be recorded.
 - b. Acceptance Criteria:



- 1) Field welds complying with the requirements specified in the AWS and ASTM specifications will be acceptable.
4. Inspections:
 - a. Inspect the high-strength bolted connections and welded connections.
 - b. Have the Professional Land Surveyor survey each elevated framed level to determine the locations of the top of steel elevations and the edge of slab locations, and verify that the structure is square, plumb, and level in accordance with AISC tolerances, including special tolerances for AECS.
 - 1) Submit a certified copy of the Professional Land Surveyor survey of the locations of the top of steel elevations and the edge of slab locations to the Program/Project Manager for approval.
 - c. Verify only erectors qualified as specified herein erect the structural steel.
 - d. Verify the welders and welding materials in the field are properly certified.
- B. Non-Conforming Work
 1. Promptly remove and replace Work that does not comply with specified requirements.
 - a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.
 2. Record the work required and the work performed to correct deficiencies in field welding.
 3. Depending on the amount of non-conforming work encountered, the amount of testing required may be modified.

3.06 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.B, 1.04B, 2.01.C, 2.01G	Add requirements for ENVISION Sustainability Rating System





SECTION 05210

STEEL JOISTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for fabricating, furnishing, and installing steel joists at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements
 - 3. Section 05120 - Structural Steel.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. American Welding Society (AWS):
 - a. ANSI/AWS D1.1/D1.1M, Structural Welding Code - Steel.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 4. Steel Joist Institute (SJI):
 - a. SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.
 - 1) ANSI/SJI-K-1.0, Standard Specifications for Open Web Steel Joists, K-Series.
 - a) SJI Standard Load Table/Open Web Steel Joists, K-Series.
 - b) SJI KCS Joists Load Table
 - c) SJI K-Series Economy Table



- d) SJI Standard Load Table in Metric Units/Open Web Steel Joists, K-Series.
- 2) ANSI/SJI-LH/DLH-1.0, Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.
 - a) SJI Standard Load Table/Longspan Steel Joists, LH-Series.
 - b) SJI Standard Load Table/Deep Longspan Steel Joists, DLH-Series.
 - c) SJI Standard Load Table in Metric Units/Longspan Steel Joists, LH-Series.
 - d) SJI Standard Load Table in Metric Units/Deep Longspan Steel Joists, DLH-Series.
- 3) ANSI/SJI-JG-1.0, Standard Specifications for Joist Girders.
 - a) Joist Girders/Design Guide Weight Table for Joist Girders (Inch-Pound Units).
 - b) Joist Girders/Design Guide Weight Table for Joist Girders (Metric Units).
- 4) SJI Recommended Code of Standard Practice for Steel Joists and Joist Girders.
- 5. The Society for Protective Coatings (SSPC):
 - a. SSPC Painting Manual.
 - 1) SSPC-SP 1, Solvent Cleaning.
 - 2) SSPC-Paint 15, Steel Joist Shop Primer.
- 6. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
 - b. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. 10 days before steel joists are to be erected, give notice to those performing other construction work related to the joist erection, such as to those performing work that must be supported by or that will provide support of the joists, to allow such items to be introduced or furnished before the joists are erected.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.



B. Sequencing:

1. Sequence the erection of steel joists to follow erection of supporting structural steel and concrete and masonry load bearing walls.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Product Data for the materials and products provided.
- 2) Post-Industrial Recycled Content Affidavit.
- 3) Post-Consumer Recycled Content Affidavit.

b. Shop Drawings:

- 1) Steel joists.

c. Certificates:

- 1) Joist Manufacturer's Certification.
- 2) Fabricator Welders Certification.
- 3) Erector Welders Certification.

d. Special Procedure Submittals:

- 1) Documentation qualifying the welding processes.

e. Qualification Statements:

- 1) Steel joist fabricator qualifications.
- 2) Steel joist erector qualifications.

B. Engineered Submittals:

1. Submit drawings and calculations that are appropriately signed and sealed by a professional structural or civil engineer registered in Arizona to the design professional in responsible charge for review. Review of engineered drawings and calculations will be for general conformance with the design intent of the structure and submittal compliance.

C. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Materials
 - 1) Submit product data for recycled content indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
 - 2. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 - 1. Welding Qualifications:
 - a. Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.
 - 1) For all procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the procedure qualification test records.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M for the procedures.
 - 1) Submit certificates certifying that the welders employed to fabricate and to erect the Work of this Section have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
 - 2. Steel Joist Fabricator Qualifications:
 - a. Only employ a steel joist fabricator certified by the Steel Joist Institute (SJI) to manufacture the joists and insure they comply with SJI standards, and who has successfully fabricated steel joist systems of similar size and complexity for a continuous period of at least 5 years immediately prior to the GMP Proposal date.
 - b. Submit the steel joist fabricator's qualifications to the Program/Project Manager for approval.
 - 3. Steel Joist Erector Qualifications:
 - a. Only employ a steel joist erector who has successfully erected steel joist systems of similar size and complexity for a continuous period of 5 years immediately prior to the GMP Proposal date
 - b. Submit the steel joist qualifications to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Joist Manufacturer's Certification:



- a. Submit the joist manufacturer's certification that joists provided comply with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders for the type of joists specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver steel joists as recommended by the Steel Joist Institute (SJI).
- B. Storage and Handling Requirements:
 1. Store and handle steel joists as recommended by the Steel Joist Institute (SJI).
 - a. Handle and store joists in a manner to avoid deforming the members, to avoid excessive stresses, and to maintain the shop coat of paint intact without rusting.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Steel Joists:
 1. Provide steel joists fabricated in accordance with the requirements of 29 CFR 1926; the American Welding Society (AWS), Steel Joist Institute (SJI), and The Society for Protective Coatings (SSPC) standards listed in Paragraph 1.02.B, and as specified herein.
 2. Provide joist type as indicated on the Contract Drawings.
- B. Bridging:
 1. Provide horizontal and/or diagonal type bridging complying with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders for the type of joists being fabricated.
- C. End Anchorages:
 1. Unless otherwise indicated, provide end anchorages complying with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.
 - a. Provide anchors to secure joist ends to adjacent construction.
 - b. Provide bridging anchors for the ends of all bridging lines terminating at walls or beams.
- D. Header Units:
 1. Provide header units for K-series joists to support the tail joists at openings in the roof system not framed with steel shapes.
- E. Bearings:



1. Provide special depth bearings for K-series joists at locations shown on the Contract Drawings or where K-series joists are adjacent to LH or DLH series joists.

F. Ceiling Extensions:

1. Provide ceiling extensions in those areas where ceiling materials attach directly to joist bottom chords.
 - a. Extend such ceiling extensions no closer than one inch from wall surfaces.

2.02 MANUFACTURERS:

A. Manufacturer List:

1. Subject to compliance with the requirements specified in this Section, manufacturers offering products that may be incorporated in the Work include the following:
 - a. Nucor Corporation - Vulcraft Group, www.vulcraft.com.
 - b. The New Columbia Joist Company, a subsidiary of Bouras Industries, Inc., www.njb-united.com/ncj.
 - c. Canam Steel Corporation, <http://www.canam-steeljoists.ws/www/v4/ecanams.nsf..>
 - d. Approved equal.

2.03 REGULATORY REQUIREMENTS:

- A. Provide steel joists in compliance with the requirements of 29 CFR 1910 and 29 CFR 1926, particularly 29 CFR 1926.757 Open Web Steel Joists, and with the requirements of ICC International Building Code (IBC) as Amended by the City of Phoenix.
- B. Buy America:
 1. All steel joists used for this Contract must be American-made.
 2. Submit a guarantee certifying that all steel used for the Work of this Contract is American-made.

2.04 SUSTAINABILITY REQUIREMENTS:

A. ENVISION Requirements:

1. Recycled Content
 - a. Provide Steel Joists who's combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.



2.05 DESIGN CRITERIA:

- A. Provide steel joists designed in accordance with the requirements of 29 CFR 1926, particularly 29 CFR 1926.757 Open Web Steel Joists; and with the requirements of the American Welding Society (AWS), Steel Joist Institute (SJI), and The Society for Protective Coatings (SSPC) standards listed in Paragraph 1.02.B.
 - 1. When the strength of the member is calculated, the area of holes must be deducted from the area of chords.
- B. Provide steel joists designed to resist the specified loading indicated on the Contract Drawings.
- C. Submit the manufacturer's Product Data, for the materials and products provided, to the Program/Project Manager for approval.
 - 1. Include specifications and the manufacturer's installation instructions for each type of joist provided and its accessories.
- D. Submit Shop Drawings of the steel joists to the Program/Project Manager for approval.
 - 1. Include detailed drawings showing the layout of joist units, special connections, jointing, and accessories.
 - a. Include the mark, number, type, location, and spacing of the joists and bridging.
 - 2. Include templates or location drawings for installation of anchor bolts.

2.06 MATERIALS:

- A. Steel:
 - 1. Provide steel complying with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.
 - 2. Provide steel having a yield strength of 50,000 psi.
- B. Welding Electrodes:
 - 1. Provide welding electrodes and filler metal conforming to the requirements of the AWS standards referenced in the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.

2.07 FABRICATION:

- A. Shop Fabrication:
 - 1. Fabricate steel joists in accordance with the requirements of 29 CFR 1926; the American Welding Society (AWS), Steel Joist Institute (SJI), and



The Society for Protective Coatings (SSPC) standards listed in Paragraph 1.02.B, and as specified herein.

2. Holes in Chord Members:
 - a. Provide holes in chord members where shown for securing other work to the steel joists.

2.08 FINISHES:

- A. Primer Materials:
 1. Provide steel primer complying with the requirements for Type 1, red oxide steel joist shop paint as specified in SSPC Paint Specification No.15.
- B. Shop Finishing Methods:
 1. Before applying shop primer, remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories, and clean the surfaces with solvent in accordance with the requirements of SSPC-SP 1.
 2. Apply one coat of steel primer to the steel joists and accessories in accordance with the manufacturer's recommended procedures and mil thickness.
 - a. Minimum Thickness: 1 mil.
 3. Do not prime surfaces of fabricated joists and accessories that will be fireproofed.

2.09 ACCESSORIES

- A. Standard Accessories:
 1. Provide the manufacturer's standard accessories complying with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.
- B. Anchor Bolts and Other Devices:
 1. Furnish anchor bolts and other devices to be built into concrete and masonry construction for attaching the steel joists.
 - a. Provide anchors meeting the requirements of Section 05120, Structural Steel.
 - b. Furnish templates for accurately locating anchors in such other work.

2.10 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.



2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
 3. Materials and fabrication procedures specified in this Section require advance examination or laboratory testing by the code-required Approved Agency for performing Special Inspections and the Testing and Inspection Agency.
 - a. Provide these inspection and testing entities with access to the places where steel joists are being fabricated or produced so the required inspections and testing can be performed before the material is shipped.
 4. Inspections:
 - a. Verify that only fabricators qualified as specified herein produce the steel joists.
 - b. Shop welds made on joists are subject to inspection and testing.
- B. Non-Conforming Work:
1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.
- C. Coordination of Other Tests and Inspections:
1. Notify the code-required Approved Agency responsible for performing special inspections when steel joists for this Contract are being fabricated, shipped, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Prior to erecting the steel joists, have the steel joist erector verify that the preparatory work is complete, and ready to receive the joists.
 - a. Verify that the elevations of concrete and masonry bearing surfaces are correct.
 - b. Verify that the locations of anchors and other devices for attaching the steel joists to concrete and masonry construction are correct.
 2. Report discrepancies to the Program/Project Manager.
- B. Evaluation and Assessment:



1. Do not begin erecting steel joists until the supporting work is in place and secured.

3.02 ERECTION

- A. Place and secure steel joists in accordance with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders, the approved Shop Drawings, and as otherwise specified herein.
 1. Use only erectors qualified as specified herein.
- B. Placing Joists:
 1. Position and space the joists on the supporting work as shown on the Contract Drawings and as specified.
 2. Accurately align and adjust the location and spacing of the joists before permanently fastening them.
- C. Bridging:
 1. Install bridging between joists simultaneously with joist erection and before any construction loads are applied.
 - a. Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.
 - b. Where bridging lines terminate at walls or beams, anchor the ends of both the top and bottom chords of the bridging.
 2. Do not provide fewer rows of bridging than shown in the appropriate bridging table in the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.
 3. Provide a single line of bridging at the first bottom chord panel point at each end of every joist.
 4. Space the bridging rows in the span so that the spacing between bridging is uniform.
- D. Interface with Other Work:
 1. Fastening Joists:
 - a. Field weld the ends of joists to the supporting steel in accordance with the requirements of the SJI Catalog of Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders for the type of joist used.
 - 1) Coordinate the welding sequence and welding procedure with the placement of the joists.
 - b. Bolt joists to supporting steel at columns.

3.03 REPAIR/RESTORATION

- A. Field Painting:



1. After the joists have been installed, paint all field-installed bolt heads, nuts, and welded areas; and paint abraded or rusty surfaces on joists and steel supporting members
 - a. Wire brush and solvent clean surfaces where the prime coat has been damaged before applying this touch-up paint.
2. Use the same type of paint for field painting as was used for shop priming.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the steel joists are being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials and procedures.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Both continuous and periodic Special Inspections will be performed during the erection of steel joists.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Inspections:
 - a. Verify that only erectors qualified as specified herein erect the steel joists.
 - b. Joists welded in place are subject to inspection and testing.

B. Non-Conforming Work

1. Promptly remove and replace Work that does not comply with specified requirements.
 - a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
1	12/20/2017	N/A	1.02.A, 1.02.B, 1.04B, 2.04.A, 2.01G	Add requirements for ENVISION Sustainability Rating System



SECTION 05310

STEEL DECK

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing steel decking at locations indicated on the Contract Drawings, including the following:
 - a. Roof decking.
 - b. Composite floor decking.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 – Cast-In-Place Concrete.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
- B. Reference Standards:
 - 1. American Iron and Steel Institute (AISI):
 - a. AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. ASTM International (ASTM):
 - a. ASTM A 108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - d. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M Structural Welding Code - Steel.
 - b. AWS D1.3; Structural Welding Code - Sheet Steel.
 - 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 5. International Code Council (ICC):



- a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- b. ICC-ES Evaluation Reports, http://www.icc-es.org/Evaluation_Reports/index.shtml.
- 6. Steel Deck Institute (SDI):
 - a. SDI 30, Design Manual for Composite Decks, Form Decks and Roof Decks.
- 7. U.S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
 - 3) OSHA Directive Number CPL 02-01-034 [Old Directive Number CPL 2-1.34] Inspection Policy and Procedures for OSHA's Steel Erection Standards for Construction.
 - b. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. 10 days before steel deck is to be erected, give notice to those performing other construction work related to the deck erection, such as to those performing work that must be supported by or that will provide support of the deck, to allow such items to be introduced or furnished before the deck is erected.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- B. Sequencing:
 - 1. Sequence the erection of steel deck to follow erection of supporting structural steel, steel joists, and concrete and masonry load bearing walls.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. In accordance with the requirements of Section 01330, Submittal Procedures, submit the following to the Program/Project Manager for approval:
 - a. Product Data:
 - 1) Steel roof deck.
 - 2) Steel composite floor deck.



- 3) Mechanical fasteners.
 - 4) Rib closure strips.
 - 5) Pour stops and girder fillers.
 - 6) Column closures, end closures, Z-closures, and cover plates.
 - 7) Weld washers.
 - 8) Roof sump pans.
 - 9) Flat receiver pans.
 - 10) Galvanizing repair paint.
 - 11) Headed stud type shear connectors (studs).
 - 12) Hanger attachment devices.
 - b. Shop Drawings:
 - 1) Deck panel layout; anchorage details; conditions requiring closure panels, special jointing, and other accessories.
 - c. Certificates:
 - 1) Manufacturer's Certification
 - 2) Steel Certificate.
 - d. Delegated Design Submittals:
 - 1) Pour sequences, maximum square footage of each pour, and pour joint locations.
 - e. Special Procedure Submittals:
 - 1) Welding procedure qualification test records.
 - f. Qualification Statements:
 - 1) Installer's qualifications.
 - 2) Welder Certificates.
- B. Informational Submittals:
- 1. In accordance with the requirements of Section 01330, Submittal Procedures, submit the following to the Program/Project Manager for information:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's installation instructions.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Material
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. At least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. L

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the fabrication and erection of structural steel.
- B. Qualifications:
- 1. Installer Qualifications:
 - a. Engage an experienced Installer who has completed steel deck installation similar in material, design, and extent to that indicated for this Contract, and which exhibits a record of successful in-service performance.
 - 1) Submit the Installer's qualifications to the Program/Project Manager for approval.
 - 2. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.3, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in AWS D1.1/D1.1M or AWS D1.3:
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the



required welding procedures and, if pertinent, has undergone recertification.

C. Certifications:

1. Manufacturer's Certification:

- a. Submit a manufacturer's certification certifying the Work performed under this Section complies with the specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Use special care in shipping steel deck.
2. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - a. Deliver anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time so the Work is not delayed.

B. Storage and Handling Requirements:

1. Store decking on platforms, skids, blocking or other supports, and with one end elevated.
2. Protect decking from the weather with non-asphaltic waterproof covering, adequately ventilated to prevent condensation.
3. Do not damage decking during handling or rigging.
 - a. Do not use decking for bulk storage, or as a working platform for other construction materials.
 - b. Do not overload decking during installation and the entire construction period.
 - c. Do not place deck bundles on unbolted/unwelded building frames.
4. During installation, do not locate bundles of uninstalled decking where they will overload supporting members.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not weld decking when the base metal temperature is below 32 degrees Fahrenheit (0 degrees Celsius), or when the surface to be welded is wet.

PART 2 PRODUCTS

2.01 MANUFACTURER LIST

- A. Subject to compliance with the requirements specified in this Section, manufacturers offering products that may be incorporated in the Work include the following:

1. Vulcraft, a Division of Nucor Corporation, www.vulcraft.com.



2. Wheeling Corrugating Company, a Division of Wheeling-Pittsburgh Steel Corporation, www.wheelingcorrugating.com.
3. Verco Manufacturing Company, www.vercodeck.com.
4. Or equal.

2.02 REGULATORY REQUIREMENTS:

- A. Phoenix Building Construction Code:
 1. Provide the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments.
- B. Occupational Safety and Health Administration (OSHA):
 1. Place steel deck in compliance with the requirements of 29 CFR 1910 and 29 CFR 1926, particularly 29 CFR 1926.754, Structural Steel Assembly, related OSHA Directive Number CPL 02-01-034 [Old Directive Number CPL 2-1.34].

2.03 SUSTAINABILITY REQUIREMENTS:

- A. ENVISION Requirements:
 1. Recycled Content
 - a. Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.
 2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.

2.04 DESIGN CRITERIA

- A. Steel Deck Panels:
 1. Provide steel deck panels designed in accordance with the requirements of SDI 30, or that have an approved ICC Evaluation Service Evaluation Report listing the gravity and diaphragm load values of the decking.
 - a. Provide deck configurations complying with basic design specifications in SDI 30, and as specified herein.
 2. Structural Properties:
 - a. Provide roof and floor deck sections having structural properties computed in accordance with the AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 1) Do not support other construction from the steel roof deck, including but not limited to suspended ceilings, light fixtures, ducts, piping, conduits, other equipment, or utilities and similar items.



- B. Product Data:
 - 1. Submit the manufacturer's Product Data for each product specified and provided to the Program/Project Manager for approval.
 - 2. Submit the manufacturer's installation instructions for each product specified to the Program/Project Manager for information.
- C. Shop Drawings:
 - 1. Submit detailed Shop Drawings showing the layout of deck panels; anchorage details; and every condition requiring closure panels, special jointing, or other accessories to the Program/Project Manager for approval.
- D. Welding Standards:
 - 1. Comply with applicable provisions of AWS D1.1/D1.1M and AWS D1.3.

2.05 MATERIALS

- A. Roof Deck:
 - 1. Steel Roof Deck:
 - a. Steel Sheet: Provide steel sheet classified as Grade 33 or higher Structural Steel (SS) with Coating Designation G 60 per ASTM A 653/A 653M, and zinc coated according to ASTM A 924/A 924M.
 - b. Provide roof deck having the deck profile and depth, and the design uncoated-steel thickness, indicated on the Contract Drawings.
 - c. Provide roof deck units in lengths capable of spanning 3 or more supports, and designed with overlapping side joints, unless otherwise indicated.
 - d. For areas where insulating concrete is to be placed, provide vented decking.
- B. Floor Deck:
 - 1. Steel Composite Floor Deck:
 - a. Steel Sheet: Provide steel sheet classified as Grade 40 or higher Structural Steel (SS) with Coating Designation G 60 per ASTM A 653/A 653M, and zinc coated according to ASTM A 924/A 924M.
 - b. Provide floor deck having the deck profile depth, and the design uncoated-steel thickness, indicated on the Contract Drawings.
 - c. Provide floor deck units in lengths capable of spanning 3 or more supports, and designed with overlapping side joints, unless otherwise indicated.

2.06 SHOP FABRICATION

- A. Fabricate roof and floor panels in accordance with the requirements of SDI 30:



1. Fabricate steel composite floor deck panels with integrally embossed or raised pattern ribs and interlocking side laps, and having at a minimum the section properties indicated.
 2. Weld studs in accordance with Section 7 in AWS D1.1/D1.1M; and provide welds meeting the mechanical properties for welded Type B studs in Table 7.1.
- B. Provide decking free of lubricants and oils which would impair the adhesion of spray-on fireproofing.
- C. Accessory Fabrication:
1. Steel Sheet Accessories:
 - a. Fabricate steel sheet accessories from steel sheet classified as Grade 33 or higher Structural Steel (SS) with Coating Designation G 60 in accordance with ASTM A 653/A 653M, and within the tolerances specified in ASTM A 924/A 924M.
 2. Miscellaneous Roof Deck Accessories:
 - a. Fabricate miscellaneous roof deck accessories, such as steel sheet ridge and valley plates, finish strips, and reinforcing channels, from the same material and thickness as the roof deck.

2.07 ACCESSORIES

- A. Provide accessory materials for steel deck that comply with the requirements indicated and the recommendations of the steel deck manufacturer.
1. Mechanical Fasteners:
 - a. Provide the manufacturer's standard, corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws, that have a current approved ICC Evaluation Service Legacy Report.
 2. Rib Closure Strips:
 - a. Provide the manufacturer's standard vulcanized, closed-cell, synthetic rubber rib closure strips.
 3. Pour Stops and Girder Fillers:
 - a. Provide pour stops and girder fillers fabricated from the same steel sheet material as the deck panels, and of the thickness and profile indicated.
 4. Column Closures, End Closures, Z-Closures, and Cover Plates:
 - a. Provide column closures, end closures, Z-closures, and cover plates fabricated from the same steel sheet material and thickness as the deck panels, unless otherwise indicated.
 5. Weld Washers:
 - a. Provide the manufacturer's standard uncoated-steel sheet weld washers, shaped to fit the deck rib.
 - b. Washer Thickness: 0.0598 inch.
 - c. Pre-punched Hole Diameter: 3/8 inch, minimum.



6. Roof Sump Pans:
 - a. Fabricate roof sump pans with level bottoms and sloping sides to direct water flow to a drain from a single piece of galvanized sheet steel 0.071 inch (14 gage) thick, minimum.
 - b. Provide sump pans of adequate size to receive roof drains, and having bearing flanges not less than 3 inches wide.
 - c. Recess sump pans not less than 1-1/2 inches below the roof deck surface unless otherwise shown or required by the deck configuration.
 - d. Cut holes for drains in the roof sump pans in the field.
7. Flat Receiver Pans:
 - a. Provide the manufacturer's standard size flat receiver pans, fabricated from a single piece of the same steel sheet as the deck panels.
 - b. Receiver Pan Thickness: 0.071 inch, minimum.
 - c. Cut holes for drains in the flat receiver pans in the field.
8. Reinforcement at Deck Openings:
 - a. Unless otherwise shown, prior to cutting openings provide additional steel reinforcement and closure pieces as required to provide strength, continuity of the deck, and support for other work.
9. Galvanizing Repair Paint:
 - a. Provide high zinc-dust content paint complying with the requirements of ASTM A 780 to repair damaged galvanized surfaces.
10. Headed Stud Type Shear Connectors (Studs):
 - a. Provide headed stud type shear connectors (studs) meeting the requirements of ASTM A 108.
11. Hanger Attachment Devices:
 - a. Provide the manufacturer's standard hanger attachment devices.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the deck support framing and other field conditions for compliance with the specified installation tolerances and other conditions which may affect the performance of the steel deck.
- B. Evaluation and Assessment:
 1. Do not install steel deck on support framing insufficient to support the decking, or that would detrimentally affect the performance of the deck.

3.02 INSTALLATION

- A. Requirements Applicable to Both Roof and Floor Deck:
 1. Install roof and floor deck panels and accessories according to applicable Specifications and the commentary of SDI 30, the manufacturer's recommendations, ICC Evaluation Service Evaluation Report



requirements for the decking selected, and the requirements of this Section.

2. Cut and neatly fit roof and floor deck panels and accessories around openings and other work projecting through or adjacent to the decking.
3. Place roof and floor deck panels on supporting framing, and adjust the panels to their final position with the ends accurately aligned and bearing on the supporting framing before being permanently fastened to the framing.
 - a. Place roof and floor deck units in lengths that span 3 or more supports with overlapping side laps, unless otherwise indicated.
 - b. Place roof and floor deck panels flat and square, and fasten them to the supporting framing without warp or deflection.
 - c. Provide miscellaneous steel, as required, at columns and at beam/column moment connections to adequately support the weight of construction loadings.
 - d. Do not leave roof and floor deck unattached at the end of each day's work.
4. Comply with AWS D1.1/D1.1M and AWS D1.3 requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods for correcting welding work.

B. Additional Requirements Applicable to Roof Deck Installation:

1. Fasten roof deck panels to each steel supporting member as shown on drawings in General Structural Notes. Where deck fastening is not shown on drawings, weld the bottom flutes of roof deck panels to each steel supporting member using fusion welds as follows.
 - a. Weld the panels at each support, with a minimum of 1 weld per flute and 1 weld on each side of side seams at each support.
 - b. Weld Diameter: 3/4 inch, nominal.
 - c. Weld Spacing Parallel to Flutes: Space welds at 12 inches on center, except in the 10-foot by 10-foot area at building/diaphragm corners where 6-inch weld spacing is required.
 - d. Weld Washers: Install weld washers at each weld location recommended by the deck manufacturer.
2. Side Lap and Perimeter Edge Fastening:
 - a. Fasten side laps and perimeter edges using one of the following methods:
 - 1) Provide piercing or crimping type connections, similar to the "Punch Lok" system by Verco, spaced 24 inches apart on center.
 - a) Do not use a button punching system.
 - 2) Mechanically fasten the side laps and perimeter edges of panels located between supports using self-drilling, number 12 diameter by 3/4-inch long, galvanized carbon steel screws spaced no more than 12 inches apart.
 - a) Verify that the deck side laps have been rolled during the manufacturing process to receive screws in the side lap joint.



3. End Bearing:
 - a. Unless otherwise noted on the Contract Drawings, install deck ends over the supporting framing with a minimum end bearing of 1-1/2 inches, and with end joints overlapped.
4. Roof Sump Pans and Sump Plates:
 - a. Install roof sump pans and sump plates over openings provided in the roof decking, and weld their flanges to top of the deck.
 - b. Space welds not more than 6 inches apart with at least one weld at each corner.
5. Miscellaneous Roof Deck Accessories:
 - a. Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to the deck manufacturer's recommendations.
 - b. Weld the miscellaneous roof deck accessories to the substrate to provide a complete deck installation.
6. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work as follows:
 - a. Reinforce decking around openings having a 6-inch to 12-inch dimension in any direction by placing a steel sheet over the opening on the top of the decking, and fusion welding the sheet to the top surface of the deck.
 - 1) Provide sheet steel of the same quality as the deck units, and at least 12-inches wider and longer than the opening unless otherwise indicated on the Contract Drawings.
 - 2) Provide welds at each corner and along each side spaced not more than 12 inches apart on center.
 - b. For openings with a 12-inch or greater dimension in any direction, provide additional miscellaneous structural steel members on all sides of each opening as indicated on the Contract Drawings.
 - c. If more than one penetration occurs in a deck panel, contact the Program/Project Manager for reinforcement requirements.
 - d. Do not cut unscheduled openings through the deck without the approval of the Program/Project Manager.
- C. Additional Requirements Applicable to Floor Deck Installation:
 1. Fasten roof deck panels to each steel supporting member as shown on drawings in General Structural Notes. Where deck fastening is not shown on drawings, weld the edge ribs of floor deck panels to each steel supporting member using fusion welds or elongated welds of equal strength.
 - a. Provide welds at each flute and on each side of lap joints at flutes.
 - b. Weld Diameter: 3/4 inch, nominal (1/2-inch diameter fusion area).
 - c. Weld Washers: Install weld washers at each weld location recommended by the deck manufacturer.
 2. Side Lap and Perimeter Edge Fastening:



- a. Butt the end joints of deck panels at support beams; do not overlap them.
 - b. Mechanically fasten the side laps and perimeter edges of panels located between supports using self-drilling, number 12 diameter, carbon steel screws spaced no more than 24 inches apart.
3. End Bearing:
 - a. Install deck ends over the supporting framing with a minimum end bearing of 2 inches, and with end joints butted.
4. Shear Connectors (Studs):
 - a. Arrange and space the studs as indicated on the Contract Drawings.
 - b. Weld the shear connectors through the floor deck to the support framing according to AWS D1.1/D1.1M and the manufacturer's instructions.
 - 1) Install shear connectors in accordance with the requirements of AWS D1.1/D1.1M and ANSI/AWS D1.3 using automatic welding equipment.
 - 2) Clean the surface before welding the studs to the floor deck.
 - c. Break ferrules away from all studs.
 - d. Shear connectors shown on the Contract Drawings are based on the deck types and sizes specified.
 - 1) Should any deck be installed with characteristics different than the specified deck, increase the number of shear connectors to provide a capacity equivalent to the specified deck at no increase in Contract Price.
5. Pour Stops and Girder Fillers:
 - a. Weld steel sheet pour stops and girder fillers to the supporting structure according to SDI 30 recommendations unless otherwise indicated.
6. Floor Deck Reinforcement and Closures:
 - a. Weld steel sheet column closures, cell closures, and Z-closures to the floor deck according to SDI 30 recommendations to provide tight-fitting closures at the open ends of ribs and the sides of decking.
 - b. Weld cover plates at changes in direction of the floor deck panels unless otherwise indicated.
 - c. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work as follows:
 - 1) For openings having a 6-inch to 12-inch dimension in any direction, reinforce the decking around the openings by placing a steel sheet over the opening on the top of the decking, and fusion welding the sheet to the top surface of the deck.
 - a) Provide sheet steel of the same quality as the deck units, and at least 12-inches wider and longer than the opening unless otherwise indicated.



- b) Provide welds at each corner and spaced not more than 12-inches on center along each side.
 - 2) For openings greater than 12 inches but less than 18 inches in any direction, reinforce the decking with steel as specified in Subparagraph 3.02.C.6.c.1, and provide two No. 4 reinforcing steel bars on each side of the opening unless noted otherwise on the Contract Drawings.
 - 3) For openings having an 18-inch or greater dimension in any direction, provide additional miscellaneous structural steel members on all sides of each opening as indicated on the Contract Drawings.
 - 4) Where several penetrations in a floor deck panel must occur close together, space these openings so each penetration can be examined individually if possible; and if the following criteria cannot be met, treat each opening as a long slot with a dimension equal to the distance between the outer edges of the outer most penetration:
 - a) For a series of openings, each less than 6 inches, provide a minimum of 12 inches between the openings where the center to center dimension between the penetrations equals the largest opening diameter plus 12 inches.
 - b) For a series of openings, each greater than 6 inches but less than 10 inches, provide a minimum of 18 inches between penetrations.
 - c) For a series of openings, each greater than 10 inches but less than 18 inches, notify the Program/Project Manager of the locations prior to placing concrete.
 - 5) Do not cut unscheduled openings through the deck without the approval of the Program/Project Manager.
 - 6) If questions occur related to the type/amount of reinforcement to be provided at floor openings, contact the Program/Project Manager prior to placing concrete.
- D. Interface with Other Work:
 - 1. Provide complete deck installations ready for concrete placement onto the deck, except for minor alterations required to accommodate small floor penetrations.
 - a. Coordinate the small penetrations with the mechanical, plumbing, and electrical disciplines.
 - b. Install closure sections, pour stops, and edge bent plates as required.
 - c. Provide adequately supported deck edges capable of supporting the weight of the concrete and construction loading without additional deck alterations.
 - d. At columns, install supplemental materials of sufficient strength to provide fall protection for personnel and to prevent objects from falling through the deck to lower levels.



2. Placing Topping Materials onto Deck Panels:
 - a. Prior to placing concrete or other topping materials onto the metal deck, submit the pour sequences, maximum square footage of each pour, and pour joint locations to the Program/Project Manager for approval.
 - b. Prior to placing concrete or other topping materials onto the deck panels, refer to the Contract Drawings for guidelines to determine if the deck must be temporarily shored during placement or concreting operations; and remove foreign matter from the deck panels.
 - c. Place concrete onto the deck panels in a uniform manner over the supporting structure and from a low level to avoid impact loading.
 - d. Spread the concrete placed toward the center of the deck span.
 - e. Finish slabs in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete, and on the Contract Drawings.
3. Hangers Attached to Deck Units:
 - a. For supporting ceilings, air ducts, diffusers, or lighting fixtures, install approved hanger attachment devices, i.e. clips, where hangers are to be attached to deck units.
 - 1) Locate hanger attachment devices at not more than 24 inches apart on center in both directions, not over 9 inches from walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.
 - b. For mounting mechanical, plumbing, and electrical equipment, install adjustable metal deck hanger rod assemblies in the deck prior to placing slab concrete.
 - 1) The maximum hanger loads and minimum hanger spacing are defined on the Contract Drawings.
 - 2) Where load and spacing criteria cannot be met, install supplemental framing.

3.03 REPAIR/RESTORATION

- A. Damaged Decking:
 1. Repair or replace damaged decking prior to placing topping materials on the decking.
- B. Roof Decking Welds:
 1. Clean and repair field roof decking welds with not less than 2 coats of galvanized repair paint.
- C. Galvanizing Repairs:
 1. Repair damaged galvanized coatings by preparing surfaces and using galvanized repair paint according to the requirements of ASTM A 780 and the manufacturer's instructions.



3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when steel deck is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the erection of steel deck.
 - 2) Field welds are subject to testing and inspection.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Stud Type Shear Connector Test:
 - a. Test Procedure:
 - 1) Prior to the start of each day's production welding of headed stud type shear connectors (studs), and also after welding equipment has been moved or changed, weld and test 2 test studs in the presence of the Code Required Approved Agency for Special Inspections.
 - a) The Approved Agency will test these studs by striking the studs with a hammer until they are bent to a 30-degree angle from vertical.
 - (1) If either stud's weld fails in the weld zone during this testing, correct or adjust the welding operation and weld new studs to replace the failed stud(s).
 - (2) Test the new studs the same way the original studs were tested.
 - b) Do not begin production welding until 2 consecutively welded studs are found satisfactory by the Approved Agency.
 - c) Replace the studs which fail inspection by the Approved Agency.
 - 2) The Approved Agency will inspect and test shear connector welds according to the requirements of AWS D1.1 for stud welding.
 - a) All field-welded shear connectors will be inspected and tested according to the requirements of AWS D1.1 for stud welding.



- b) The Approved Agency will conduct the inspections and tests required, and verify that welders are properly certified.
 - (1) All shear connector welds will be visually inspected.
 - (2) When visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector, bend tests will be performed.
 - (3) When weld fracture occurs on shear connectors already tested, tests will be conducted on additional shear connectors according to the requirements of AWS D1.1.
 - b. Acceptance Criteria:
 - 1) The stud type shear connectors must pass the testing as specified in the test procedure.
 - 3. Confirmation Testing:
 - a. Test Procedure:
 - 1) The Code Required Approved Agency for Special Inspections will perform additional tests, at the Contractor's expense, as necessary to reconfirm any noncompliance of the original work, and to show compliance of corrected work.
 - b. Acceptance Criteria:
 - 1) The work must conform to specified requirements.
 - 4. Inspections:
 - a. Verify that only erectors qualified as specified herein erect the steel deck.
 - b. After placing the decking but prior to placing topping materials, inform the Code Required Approved Agency for Special Inspections that the decking is ready to be inspected for tears, dents, and other damage that may prevent the deck from acting as a form or diaphragm.
 - c. All welds will be visually inspected.
- B. Non-Conforming Work
 - 1. Correct deficiencies in steel deck Work and shear connector placement that inspections and test reports have indicated are not in compliance with specified requirements.
 - a. Record the work required and performed to correct deficiencies.
 - b. Promptly remove and replace Work that does not comply with specified requirements.

3.05 CLEANING

- A. Prior to placing topping materials onto the deck panels, remove all soil, debris, standing water, loose mill scale, and other foreign matter from the deck panels.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.06 PROTECTION

- A. Protect and maintain the steel decking to ensure that it is not damaged or deteriorated by the time topping materials are placed.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All.	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.B, 2.03.A	Add requirements for ENVISION Sustainability Rating System





SECTION 05314

LONG SPAN STEEL ROOF DECK

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing long span steel roof decking at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. DFT: Dry film thicknesses.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. NRC: Noise reduction coefficient.
- B. Reference Standards:
 - 1. American Iron and Steel Institute (AISI):
 - a. AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - c. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - d. ASTM C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.



- e. ASTM E 795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests.
- 3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M Structural Welding Code - Steel.
 - b. AWS D1.3; Structural Welding Code - Sheet Steel.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 6. ICC Evaluation Service, Inc. (ICC ES), <http://www.icc-es.org/reports/index>:
 - a. ICC ES Report™ ESR-2196 – Hilti Kwik-Pro Self-Drilling Screws.
- 7. Steel Deck Institute (SDI):
 - a. SDI 30, Design Manual for Composite Decks, Form Decks and Roof Decks.
- 8. U.S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
 - 3) OSHA Directive Number CPL 02-01-034 [Old Directive Number CPL 2-1.34] Inspection Policy and Procedures for OSHA's Steel Erection Standards for Construction.
- 9. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the location and size of shop cut access openings in the bottom of the long span steel roof decking panels required to accommodate the Work of other Sections with the decking manufacturer.
- 2. 10 days before steel deck is to be erected, give notice to those performing other construction work related to the deck erection, such as to those performing work that must be supported by or that will provide support of the deck, to allow such items to be introduced or furnished before the deck is erected.
- 3. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

B. Sequencing:



1. Sequence the erection of steel deck to follow erection of supporting structural steel, steel joists, and concrete and masonry load bearing walls.

1.04 SUBMITTALS

A. Action Submittals:

1. In accordance with the requirements of Section 01330, Submittal Procedures, submit the following to the Program/Project Manager for approval:
 - a. Product Data:
 - 1) Steel roof deck.
 - 2) Roof deck thermal insulation.
 - 3) Roof deck acoustic insulation.
 - 4) Rib closure strips.
 - 5) Pour stops and girder fillers.
 - 6) Flat receiver pans.
 - 7) Reinforcement at deck openings, including column closures, end closures, Z-closures, and cover plates.
 - 8) Access panels; full width.
 - 9) Mechanical fasteners.
 - 10) Galvanizing repair paint.
 - 11) Hanger attachment device.
 - 12) Finishes.
 - 13) Post-Industrial Recycled Content Affidavit.
 - 14) Post-Consumer Recycled Content Affidavit.
 - b. Shop Drawings:
 - 1) Deck panel layout; deck profile and material thickness; finish; anchorage details; conditions requiring closure panels, special jointing, and other accessories.
 - c. Certificates:
 - 1) Manufacturer's Certification
 - 2) Steel Certificate.
 - d. Special Procedure Submittals:
 - 1) Welding procedure specification (WPS) test records.
 - e. Qualification Statements:
 - 1) Installer's qualifications.
 - 2) Welder Certificates.

B. Informational Submittals:

1. In accordance with the requirements of Section 01330, Submittal Procedures, submit the following to the Program/Project Manager for information:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's installation instructions.



2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied paint used to touch up shop applied primer.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Long Span Steel Roof Deck Installer's Qualifications:
 - a. Engage an experienced Installer who has completed steel deck installation similar in material, design, and extent to that indicated for this Contract, and which exhibits a record of successful in-service performance.
 - 1) Submit the Installer's qualifications to the Program/Project Manager for approval.
2. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):



- 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
- 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.3, submit a copy of the welding procedure qualification test records (PQRs) and welding procedure specifications (WPSs) to the Program/Project Manager for approval.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M or AWS D1.3 for the procedures.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

C. Certifications:

1. Manufacturer's Certification:
 - a. Submit a manufacturer's certification certifying the Work performed under this Section complies with the specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Use special care in shipping steel deck.
2. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.

B. Storage and Handling Requirements:

1. Store decking on platforms, skids, blocking or other supports, and with one end elevated.
2. Protect decking from the weather with non-asphaltic waterproof covering, adequately ventilated to prevent condensation.
3. Do not damage decking during handling or rigging.
 - a. Do not use decking for bulk storage, or as a working platform for other construction materials.



- b. Do not overload decking during installation and the entire construction period.
- c. Do not place deck bundles on unbolted/unwelded building frames.
- 4. During installation, do not locate bundles of uninstalled decking where they will overload supporting members.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not weld decking when the base metal temperature is below 32 degrees Fahrenheit (0 degrees Celsius), or when the surface to be welded is wet.

PART 2 PRODUCTS

2.01 LONG SPAN STEEL ROOF DECK SYSTEM

- A. Manufacturer List
 - 1. Subject to compliance with the requirements specified in this Section, manufacturers offering products that may be incorporated in the Work include the following:
 - a. Epic® Metals Corporation, www.epicmetals.com.
 - b. Metal Dek Group, a Unit of CSi® (Consolidated Systems Incorporated), <http://www.metaldek.com>.
 - c. Approved equal.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. Federal Occupational Safety and Health Administration (OSHA) Requirements:
 - 1) Place steel deck in compliance with the requirements of 29 CFR 1910 and 29 CFR 1926, particularly 29 CFR 1926.754, Structural Steel Assembly, related OSHA Directive Number CPL 02-01-034 [Old Directive Number CPL 2-1.34].
 - 2. Sustainability Requirements:
 - a. Sustainability Requirements:
 - 1) Recycled Content
 - a) Provide Long Span Steel Roof Deck whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 20 percent.



- b) Provide Glass Fiber insulation whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 20 percent.
 - 2) Low Emitting Materials – Paints and Coatings
 - a) When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.
- C. Performance:
 - 1. Fire Hazard Rating:
 - a. Provide insulation, both thermal and acoustic types, having a Class 2 (Flame Spread of 75 or less; Smoke Development rating of 450 or less) rating when tested in accordance with the methods specified in ASTM E 84.
 - 2. Acoustic Type Panels:
 - a. For interior spaces, provide acoustic type panels having a noise reduction coefficient (NRC) of at least 0.9 as established by testing the panels in accordance with the methods specified in ASTM C 423.
 - b. Provide acoustic insulation in the cells of acoustic type panels so additional acoustic insulation is not required above the panels to achieve the specified noise reduction coefficient (NRC).
- D. Design Criteria:
 - 1. Steel Deck Panels:
 - a. Provide steel deck panels designed in accordance with the requirements of SDI 30, listing the gravity and diaphragm load values of the decking.
 - 1) Provide deck configurations complying with basic design specifications in SDI 30, and as specified herein.
 - b. Structural Properties:
 - 1) Provide roof deck sections having at a minimum the structural properties required by the General Structural Notes on the Contract Drawings and computed in accordance with the AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2) Access Panels:
 - a) Provide access panels and fastenings for those panels in accordance with the manufacturer's recommendations.
 - b) Provide roof deck panels that have access panels or other modifications that have the same carrying capacity as panel sections not having the access panels or other modifications.
 - 2. Welding Standards:
 - a. Comply with applicable provisions of AWS D1.1/D1.1M and AWS D1.3.
 - 3. Product Data:



- a. Submit the manufacturer's Product Data for each product specified and provided to the Program/Project Manager for approval.
 - 1) Include data regarding the steel roof deck properties.
 - 2) Include data regarding the steel roof deck finishes.
 - b. Submit the manufacturer's installation instructions for each product specified to the Program/Project Manager for information.
4. Shop Drawings:
- a. Submit detailed Shop Drawings showing the layout of deck panels; deck profile and material; finish; anchorage details; and every condition requiring closure panels, special jointing, access panel opening locations and details, and other accessories to the Program/Project Manager for approval.
 - 1) Indicate areas to receive acoustic insulation, thermal insulation, or both types of insulation.

2.02 COMPONENTS

A. Roof Deck:

1. Steel Roof Deck:
 - a. Steel Sheet: Provide steel sheet classified as Grade 40 or higher Structural Steel (SS) with Coating Designation G 60 per ASTM A 653/A 653M, and zinc coated according to ASTM A 924/A 924M.
 - b. Provide roof deck having the deck profile, depth, and the design uncoated-steel thickness indicated on the Contract Drawings.
2. Roof Deck Thermal Insulation:
 - a. Provide factory-installed roof deck thermal insulation consisting of two-component polyurethane foam which cures to a semi-rigid closed cell foam upon the chemical reaction of the components.
 - 1) Spray-apply the insulation to the roof panels to insulate, fill, and seal voids; deaden sound; and reduce vibration in the panels.
 - b. Provide roof deck thermal insulation having the characteristics specified in Table 05314-1.

Table 05314-1 Roof Deck Thermal Insulation Characteristics		
Characteristic	Value	Test Method
Density	1.75 pound per cubic foot (28kg/m ³)	ASTM D 1622
K-Factor	0.182 BTU-inches per square foot-hour-degree Fahrenheit (W/m·K)	ASTM C 518
R-Value	6.2 per inch after aging 28 days	N/A



Table 05314-1 Roof Deck Thermal Insulation Characteristics		
Characteristic	Value	Test Method
Air Barrier Properties		
At a pressure of 6.24 pounds per square foot (300Pa)	Less than 0.01 cubic feet per minute per square foot (0.05L/s/m ²)	ASTM E 283
At a pressure of 1.57 pounds per square foot (75Pa)	Less than 0.0025 cubic feet per minute per square foot (0.0125L/s/m ²)	ASTM E 283
Perm Rating		
For 1 inch (2.54cm)	1.99	ASTM E 96, Method A
For 2.5 inches (6.35cm)	1.18	ASTM E 96, Method A
Tensile Strength in the parallel direction	46 psi (317kPa)	ASTM D 1623
Compressive Strength		
In the parallel direction at 10 percent	27 psi (186kPa)	ASTM D 1621
In the perpendicular direction at 10 percent	18 psi (124kPa)	ASTM D 1621
Dimensional Stability		
Heat Age - Plus 158 degrees Fahrenheit (70°C)	Minus 0.6 percent	ASTM D 2126
Humid Age - Plus 158 degrees Fahrenheit (70°C), 100 percent Relative Humidity	Plus 2.9 percent	ASTM D 2126
Cold Age - Minus 4 degrees Fahrenheit (-20°C)	Minus 0.3 percent	ASTM D 2126
Closed Cell Content	Greater than 90 percent	ASTM D 2856
Fire Rating	Class 2 (Flame Spread of 75 or less; Smoke Development rating of 450 or less)	ASTM E 84

c. Manufacturers:



- 1) Fomo Products, Inc., www.fomo.com.
 - 2) Approved equal.
3. Roof Deck Acoustic Insulation:
 - a. Provide glass fiber acoustic insulation batts.
 - 1) Provide insulation resistant to the effects of moisture, oil, grease, and most acids; and that resists shrinking, settling, breakdown, and sagging caused by vibration.
 - a) Moisture Absorption: Less than 1.0 percent by volume.
 - 2) Provide insulation that does not breed or promote the growth of fungi and bacteria.
 - b. Provide a black acrylic coating on the underside of the insulation.
- B. Rib Closure Strips:
 1. Provide the manufacturer's standard vulcanized, closed-cell, synthetic rubber rib closure strips.
- C. Pour Stops and Girder Fillers:
 1. Provide pour stops and girder fillers fabricated from the same steel sheet material as the deck panels, and of the thickness and profile indicated.
- D. Flat Receiver Pans:
 1. Provide the manufacturer's standard size flat receiver pans, fabricated from a single piece of the same steel sheet as the deck panels.
 2. Receiver Pan Thickness: 0.071 inch, minimum.
 3. Cut holes for drains in the flat receiver pans in the field.
- E. Reinforcement at Deck Openings:
 1. Unless otherwise shown, prior to cutting openings provide additional steel reinforcement and closure pieces as required to provide strength, continuity of the deck, and support for other work, including column closures, end closures, Z-closures, and cover plates.
- F. Access Panels:
 1. Provide access panels fabricated from steel and having the same steel grade and thickness as the deck material specified in the General Structural Notes on the Contract Drawings.
 - a. Provide Envista FNA Hinged Access Panels, or approved equal.
 - 1) Size: As indicated in Contract Drawings.
 - 2) Factory prime access panels and hinge.
 - 3) Finish: High-performance coating as specified.
 - 4) Color: match adjacent deck surface
 - b. If the deck material is not specified in the General Structural Notes on the Contract Drawings, at a minimum provide 18 gage steel.
 - c. Galvanize, paint, and fabricate the access panels to match the profile of adjacent deck surfaces, including stiffening ribs and perforations.



- d. Coordinate the access panel sizes with the access panel opening sizes in the roof decking.
2. Apply a finish to the access panels matching the finish of the adjacent deck surfaces.
3. Install Number 10 screws, furnished by the long span steel roof deck manufacturer for attaching the access panels in the field, through screw holes pre-punched in the access covers 4 inches to 8 inches apart on center in accordance with the manufacturer's requirements.

2.03 FINISHES:

- A. Provide the long span steel roof deck manufacturer's standard finish.
 1. If the manufacturer's system is typically finished in the field, comply with the finish requirements specified in Section 09960, High-Performance Coatings, and shop-prime the deck with primers compatible with the field-applied coatings.
 2. If the manufacturer's system is typically finished in the shop, comply with the finish requirements specified in this Article.
- B. Primer Materials:
 1. Provide an epoxy primer.
 2. Manufacturers:
 - a. Metal Dek Group, a Unit of CSI® (Consolidated Systems Incorporated), Versa-Shield™ 10 Paint System, <http://www.metaldek.com>.
 - b. Approved equal.
- C. Finish Materials:
 1. Provide a polyamide epoxy intermediate coat.
 2. Provide an aliphatic polyurethane topcoat.
 3. Provide the color selected by the Program/Project Manager from the manufacturer's full range.
 4. Manufacturer:
 - a. Metal Dek Group, a Unit of CSI® (Consolidated Systems Incorporated), Versa-Shield™ 10 Paint System, <http://www.metaldek.com>.
 - b. Approved equal.
- D. Shop Finishing Methods:
 1. Prior to painting the bottom surfaces of the steel roof deck members, chemically clean the galvanized steel, and then coat it with a pretreatment.
 2. Following the pretreatment, factory-spray-apply the three-coat system to the members so they have the following dry film thicknesses (DFT); and oven-cure the system:
 - a. Primer:



- 1) Apply primer so its dry film thickness is within the range from 0.2 mil to 0.3 mil.
- b. Intermediate Coat:
 - 1) Apply the intermediate coat so its dry film thickness is within the range from 2.0 mils to 6.0 mils.
- c. Topcoat:
 - 1) Apply the topcoat so its dry film thickness is within the range from 20 mils to 30 mils.

2.04 SHOP FABRICATION

- A. Provide roof panels cold-formed by the continuous roll forming process, and resistance-welded together to form an integral unit.
 1. Fabricate the roof deck panels to have interlocking and vertically self-aligning sidelaps that produce a flush appearance with tight fitting joints from the underside.
 2. Roll-form shallow stiffening ribs into the bottom plates of roof deck.
 - a. Locate the ribs in the area between the webs to enhance the flatness of the bottom plate.
 3. Access Panel Openings:
 - a. Shop-cut openings for access panels between the ribs in the bottom plate area of the long span steel roof decking as follows, or as recommended by the manufacturer to comply with requirements to maintain the structural properties of the long span steel roof decking.
 - 1) Cut openings 6 inches wide by the required length, but not more than 8 feet long.
 - 2) Coordinate the access panel opening sizes cut into the bottom of the roof decking with the access panel sizes.
 - 3) Maintain at least 12 inches between adjacent access panel openings.
- B. Acoustic Type Panels:
 1. Acoustic Insulation:
 - a. In the cells of acoustic type panels, provide factory-installed acoustic insulation batts.
 2. To enhance the acoustic performance of the panels, perforate the bottom plates of acoustic type panels between the webs so there are uniform rows of perforations.
 - a. Install the insulation so the black acrylic coating on the underside of the insulation faces the perforations.
 - b. To avoid plugging the perforated holes in the panels during field painting, support the acoustic insulation above the bottom plate by providing either individual clips or continuous mesh.



- C. After forming and welding the roof panels, paint the bottom surfaces of the panels with the manufacturer's standard primer at the factory to insure exposed welds are coated.
 - 1. Before factory painting the exposed galvanized steel panel, chemically clean it, next apply an acid wash pretreatment, followed by a coat of the manufacturer's standard primer, and then oven bake the panel.
 - 2. It is the responsibility of the Contractor to provide field-applied finish paint compatible with the factory applied prime paint if field repairs are required, or if the finish coat is to be applied in the field.
- D. Steel Sheet Accessories:
 - 1. Fabricate steel sheet accessories from steel sheet classified as Grade 40 or higher Structural Steel (SS) with Coating Designation G60 in accordance with ASTM A 653/A 653M, and within the tolerances specified in ASTM A 924/A 924M.
- E. Miscellaneous Roof Deck Accessories:
 - 1. Fabricate miscellaneous roof deck accessories, such as finish strips, from the same material and thickness as the roof deck.

2.05 ACCESSORIES

- A. Provide accessory materials for the steel roof deck that comply with the requirements indicated and the recommendations of the steel roof deck manufacturer.
 - 1. Mechanical Fasteners:
 - a. Provide the manufacturer's standard, corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws, that have a current approved ICC Evaluation Service Report.
 - b. Manufacturers:
 - 1) Hilti Corporation, KWIK-Pro Self-Drilling Screws 12-24 HWH, ICC ES Report ESR-2196, <http://www.us.hilti.com/holus>.
 - 2) ITW Buildex and Illinois Tool Works, Inc., TEKS® self-drilling tapping screws 12-24 HWH, ICC ES Report ESR-1976, <http://www.itwbuildex.com>
 - 3) Approved equal.
 - 2. Galvanizing Repair Paint:
 - a. Provide high zinc-dust content paint complying with the requirements of ASTM A 780 to repair damaged galvanized surfaces.
 - 3. Hanger Attachment Device:
 - a. Consult the manufacturer's product data for minimum spacing, load capacities, and proper installation procedure of the hanging devices.
 - b. Coordinate the total imposed load criteria and the allowable spacing requirements for hanger embeds placed into the metal decking so they do not exceed the values indicated on the Contract Drawings.



- c. Manufacturers:
 - 1) Böllhoff Rivnut, Inc., Rivnuts®, www2.boellhoff.com.
 - 2) ITW Buildex and Illinois Tool Works, Inc., Sammy X-Press®, www.ibwbuildex.com.
 - 3) Approved equal.
- 4. Air Dams:
 - a. Provide air dams where panels continue from the interior of the building through to the exterior of the building, to block the movement of conditioned air from the interior of the building to the exterior.

2.06 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
 - 3. Materials and fabrication procedures specified in this Section require advance examination or laboratory testing by the code-required Approved Agency for performing Special Inspections and the Testing and Inspection Agency.
 - a. Provide these inspection and testing entities with access to the places where steel deck is being fabricated or produced so the required inspections and testing can be performed before the material is shipped.
 - 4. Noise Reduction Coefficient (NRC) Test:
 - a. Test Procedure:
 - 1) Representative samples of acoustic type panels will be tested in accordance with the method specified in ASTM C 423 and ASTM E 795 to determine the noise reduction coefficient (NRC) of the fabricated panels.
 - b. Acceptance Criteria:
 - 1) The acoustic type panels must have a noise reduction coefficient (NRC) of at least 0.9 to pass the Noise Reduction Coefficient (NRC) Test.

B. Non-Conforming Work:



1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.
- C. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when steel deck for this Contract is being fabricated, shipped, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the deck support framing and other field conditions for compliance with the specified installation tolerances and other conditions which may affect the performance of the steel deck.
- B. Evaluation and Assessment:
 1. Do not install steel deck on support framing insufficient to support the decking, or that would detrimentally affect the performance of the deck.

3.02 INSTALLATION

- A. Before the roof deck is permanently fastened, place the deck on the supporting frame, and adjust it to its final position with its ends accurately aligned and adequately bearing on the supporting frame.
 1. Maintain consistent coverage so the panels located in adjacent bays will be properly aligned.
- B. Cut roof deck to suit Site conditions in a neat and professional manner.
 1. Only cut those openings indicated on the structural Contract Drawings.
 2. Cut and reinforce other openings required only as approved by the Program/Project Manager.
- C. Fasten the roof deck to the supporting members as specified in the General Structural Notes on the Contract Drawings.
 1. If the roof deck fastening requirements are not specified in the General Structural Notes on the Contract Drawings, provide three 3/4-inch diameter puddle welds for each 24-inch wide panel to fasten the roof deck to the supporting members, or fasten the roof deck as indicated on the manufacturer's erection drawings.
 2. Fasten the sides of roof deck located at the perimeter of the building to supporting members as indicated on the Contract Drawings.



- a. If the fastening requirements for the sides of roof deck located at the perimeter of the building are not indicated on the Contract Drawings fasten the sides with 3/4-inch diameter puddle welds at a maximum spacing of 12 inches on center or less as indicated on the manufacturer's erection drawings.
3. Fasten the roof deck sidelaps together as indicated on the Contract Drawings.
 - a. If the fastening requirements for the roof deck sidelaps are not indicated on the Contract Drawings fasten the roof deck sidelaps using Number 12 screws spaced apart a maximum of 36 inches on center or less as indicated on the manufacturer's erection drawings.
- D. Do not apply construction loads to the deck until after the panels are permanently fastened to supporting members, and the sidelaps are attached.
 1. Do not apply construction loads exceeding the capacity of the panels.
- E. Do not suspend items such as ceilings, light fixtures, conduit, pipe and ductwork from the roof deck without specific approval from the Program/Project Manager.
- F. Fasten transition plates, eave plates, and supplied reinforcement for small openings as indicated on the manufacturer's erection drawings.
- G. Do not leave roof deck unattached at the end of each day's work.
- H. Perform connecting welding work in accordance with the requirements specified in AWS D1.1/D1.1M and AWS D1.3.
- I. Interface with Other Work:
 1. Hangers Attached to Deck Units:
 - a. For supporting ceilings, air ducts, diffusers, or lighting fixtures, install approved hanger attachment devices, where hangers are to be attached to deck units.
 - 1) Provide the manufacturer's standard hanger attachment devices.
 - 2) For spacing, restrictions, load capacities, and proper installation procedures, consult the manufacturer's Product Data.
 - 3) Do not suspend items from the roof panels without the approval of the Program/Project Manager.

3.03 REPAIR/RESTORATION

- A. Damaged Decking:
 1. Repair or replace damaged decking prior to placing topping materials on the decking.
- B. Roof Decking Welds:



1. Clean and repair field roof decking welds with not less than 2 coats of galvanized repair paint.
- C. Galvanizing Repairs:
 1. Repair damaged galvanized coatings by preparing surfaces and using galvanized repair paint according to the requirements of ASTM A 780 and the manufacturer's instructions.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when steel deck is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the erection of steel deck.
 - 2) Field welds are subject to testing and inspection.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Confirmation Testing:
 - a. Test Procedure:
 - 1) The Code Required Approved Agency for Special Inspections will perform additional tests, at the Contractor's expense, as necessary to reconfirm any noncompliance of the original work, and to show compliance of corrected work.
 - b. Acceptance Criteria:
 - 1) The work must conform to specified requirements.
 3. Inspections:
 - a. Verify that only erectors qualified as specified herein erect the steel deck.
 - b. After placing the decking, inform the Code Required Approved Agency for Special Inspections that the decking is ready to be inspected for tears, dents, and other damage that may prevent the deck from acting as a diaphragm.
 - c. All welds will be visually inspected.

**B. Non-Conforming Work**

1. Correct deficiencies in steel deck placement that inspections and test reports have indicated are not in compliance with specified requirements.
 - a. Record the work required and performed to correct deficiencies.
 - b. Promptly remove and replace Work that does not comply with specified requirements.

3.05 PROTECTION

- A. Protect and maintain the steel decking to ensure it is not damaged or deteriorated by the time topping materials are placed.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	03/12/2018	N/A	Edited 1.02.A.2., edited 1.02.B.9.a., new 1.04.A.1.a.13), new 1.04.A.1.a.14), deleted 1.04.A.1.c.3), deleted 1.04.A.1.c.4), new 1.04.B.2., deleted 1.04.C., deleted 1.05.C.2., deleted 1.05.D., new 2.01.B.2.	Updated sustainability information.



SECTION 05400

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cold-formed metal framing units, including C-shaped steel studs.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 09260 - Gypsum Board Assemblies.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users..
- B. Reference Standards:
 - 1. American Iron and Steel Institute (AISI):
 - a. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
 - b. AISI S200 - North American Standard for Cold-Formed Steel Framing – General Provisions.
 - c. AISI S201 - North American Standard for Cold-Formed Steel Framing – Product Data.
 - d. AISI S210 - North American Standard for Cold-Formed Steel Framing – Floor and Roof System Design.
 - e. AISI S211 - North American Standard for Cold-Formed Steel Framing – Wall Stud Design.
 - f. AISI S212 - North American Standard for Cold-Formed Steel Framing Header Design.
 - g. AISI S213 - North American Standard for Cold-Formed Steel Framing – Lateral Design.



2. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
3. American Welding Society (AWS):
 - a. AWS D1.3 - Structural Welding Code–Sheet Steel.
4. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM A 1003/A 1003M – Standard Specification for Steel Sheet, Carbon, Metallic and Non-Metallic Coated for Cold-Formed Framing Members.
 - c. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - d. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - e. ASTM C 955 – Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. ICC Evaluation Service, Inc. (ICC ES), <http://www.icc-es.org/reports/index>:
 - a. ICC-ES Evaluation Reports.
8. The Society for Protective Coatings (SSPC):
 - a. SSPC-SP 2 – Hand Tool Cleaning.
 - b. SSPC-SP 3 – Power Tool Cleaning.
 - c. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved



Agency, and the City, prior to incorporating items requiring testing by them into the Work.

2. Coordinate the layout and support requirements for Work interfacing with the cold-formed metal framing.

B. Pre-Installation Meetings:

1. Prior to the start of the metal framing system installation, convene a meeting at the Site in accordance with the requirements specified in Section 01316, Project Meetings, to review areas of potential interference and conflicts with the installers of other Work, such as door and window frames, mechanical Work, and electrical Work; and to review Special Inspections that may be required by the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

C. Sequencing:

1. Coordinate the cold-formed metal framing fabrication schedule with construction progress to avoid delaying the work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Studs and joists.
 - 2) Welding electrodes.
 - 3) Mechanical fasteners.
 - 4) Rust-inhibitive primer.
 - 5) Post-Industrial Recycled Content Affidavit.
 - 6) Post-Consumer Recycled Content Affidavit.
 - b. Shop Drawings:
 - 1) Plans, elevations, and details of cold-formed metal wall and ceiling framing systems.
 - c. Certificates:
 - 1) Cold-formed steel mill certificates or certified test reports.
 - d. Delegated Design Submittals:
 - 1) Professional Engineer's calculations.
 - e. Qualification Statements:
 - 1) Cold-formed metal framing fabricator's qualifications.
 - 2) Cold-formed metal framing installer/framer's qualifications.
 - 3) Professional Engineer's qualifications.
 - 4) Welding procedure qualification test records (PQRs).
 - 5) Welding procedure specifications (WPSs).
 - 6) Welding Certificates.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) ICC-ES Evaluation Reports for manufactured connectors.
 - b. Manufacturer's Instructions:
 - 1) Letters from the stud and joist manufacturers indicating welding electrodes qualified for use with the studs and joists.
 - 2) Manufacturer's installation instructions for each component and accessory.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Material
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. At least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of cold-formed metal framing.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
3. Fire-Rated Assemblies:
 - a. For framing units that are components of assemblies required by the Contract Documents to have a fire-resistance rating, including those



assemblies required to comply with governing regulations, provide units that have been approved by the Authorities Having Jurisdiction.

B. Qualifications:

1. Cold-Formed Metal Framing Fabricator's Qualifications:

- a. Employ a cold-formed metal framing fabricator that has a minimum of 5 years of continuous experience successfully fabricating in-service cold-formed metal framing similar to that indicated for this Contract.
 - 1) The cold-formed metal framing fabricator chosen, and its Subcontractors, must be members of the Steel Framing Alliance (SFA).
- b. Employ a cold-formed metal framing fabricator having sufficient production capacity to produce and deliver the materials in time to meet the approved construction schedule for this Contract.
- c. Submit the cold-formed metal framing fabricator's qualifications to the Program/Project Manager for approval.

2. Cold-Formed Metal Framing Installer/Framer's Qualifications:

- a. Employ a cold-formed metal framing installer/framer that has a minimum of 5 years of continuous experience successfully installing and framing cold-formed metal framing systems similar to those indicated for this Contract.
 - 1) The cold-formed metal framing installer/framer chosen, and its Subcontractors, must be members of the Steel Framing Alliance (SFA).
- b. Submit the cold-formed metal framing installer/framer's qualifications to the Program/Project Manager for approval.

3. Professional Engineer's Qualifications:

- a. Employ an independent Professional Engineer, registered in the State of Arizona, who has a minimum of 5 years experience, and who is qualified to perform the structural design calculations and to prepare the details and specifications required under this Section.
- b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.

4. Welding Qualifications:

- a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.3, submit a copy of the welding procedure qualification test records (PQRs) and welding procedure specifications (WPSs) to the Program/Project Manager for approval.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.



- 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.3 for the procedures.
- 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

C. Certifications:

1. Cold-Formed Steel Mill Certification:
 - a. Submit mill certificates, signed by the producer of the rolled cold-formed steel products, or certified test reports from a qualified independent testing agency, certifying the products provided comply with the specified requirements, to the Program/Project Manager for approval.
 - 1) Certify the material provided conforms to the appropriate ASTM specification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
2. Mark and color-code materials and members in accordance with industry standards AISI S200 and AISI S201.

B. Storage and Handling Requirements:

1. Protect fastener and connector products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener and connector products in a protected shelter, remove fastener and connector components only as necessary, and promptly return unused fasteners and connector to protected storage.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



PART 2 PRODUCTS

2.01 METAL FRAMING COMPONENTS

A. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

2. Sustainability Requirements:

a. ENVISION Requirements:

- 1) Recycled Content
 - a) Provide Steel Joists who's combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.

B. Performance:

1. Allowable Deflections:

a. Unless otherwise indicated in the Contract Documents, provide cold-formed metal framing designed to accommodate the following maximum allowable deflections for the application indicated:

- 1) Exterior glazed wall horizontal deflection: $L/600$, where L is the wall height.
 - a) Design exterior walls to comply with horizontal deflection requirements without considering contributions from sheathing materials
- 2) Exterior un-glazed wall horizontal deflection: $L/240$, where L is the wall height.
 - a) Design exterior walls to comply with horizontal deflection requirements without considering contributions from sheathing materials
- 3) Interior wall horizontal deflection: $L/360$, where L is the wall height.
- 4) Ceiling joist vertical deflection in ceilings accessible for maintenance or storage: $L/480$, where L is the span length.
- 5) Ceiling tile support system vertical deflection: $L/240$, where L is the span length.
- 6) Finished ceiling (gypsum board) support system vertical deflection: $L/360$, where L is the span length.

C. Design Criteria:

1. Design Standards:

- a. Design, fabricate, and erect materials for the Work of this Section in accordance with the American Iron and Steel Institute (AISI)



requirements specified in AISI S100, AISI S200, AISI S201, AISI S210, AISI S211, AISI S212, and AISI S213.

- 1) Provide cold-formed metal framing having at a minimum the wall thicknesses and the floor and ceiling depths shown in the Contract Drawings.
2. Design Loads:
 - a. Provide cold-formed metal framing designed to accommodate the design live and dead loads specified in the ICC International Building Code (IBC) as Amended by the City of Phoenix and ASCE/SEI 7, but not less than the following uniform live loads:
 - 1) Load perpendicular to exterior walls: 30 pounds per square foot.
 - 2) Load perpendicular to interior walls in public occupied areas: 10 pounds per square foot.
 - 3) Load perpendicular to interior walls in non-public occupied areas: 5 pounds per square foot.
 - 4) Vertical loads on ceilings accessible for maintenance or storage: 40 pounds per square foot.
 - 5) Vertical loads on inaccessible ceilings: 10 pounds per square foot.
 - b. For wind and seismic loading requirements, comply with the design criteria indicated on the Contract Drawings.
3. Product Data;
 - a. Submit Product Data for each component and accessory proposed for the cold-formed metal framing to the Program/Project Manager for approval.
 - 1) Include Product Data for the anchors and connectors required by the design delegated to the Contractor-employed Professional Engineer.
4. Shop Drawings:
 - a. Submit Shop Drawings showing plans, elevations, and details of cold-formed metal wall and ceiling framing systems to the Program/Project Manager for approval.
 - 1) Show the layout, spacing, sizes, capacities, thicknesses, fabricated lengths, and types of cold-formed metal framing.
 - 2) Show reinforcing channels, framing out of openings including header and door framing details, supplemental framing, strapping, bracing, bridging, splices, accessories, and attachments to adjoining Work.
 - a) Include lateral bracing drawings and details.
 - 3) Show the types and sizes of fasteners and anchors, including manufactured connectors and mechanical fasteners, and anchorage and connection details.
5. Calculations:
 - a. Have the Professional Engineer perform the design calculations required to size members, and prepare details of connections and



other structural data including specifications for fasteners, anchors, and other structural items required.

- 1) Calculate the structural properties of studs and joists in accordance with the requirements specified in AISI S100.
- b. Submit the Professional Engineer's calculations to the Program/Project Manager for approval.

D. Materials:

1. Studs and Joists:

- a. Provide steel studs and joists of the type, size, shape, and thickness (mils/gage) indicated on the Shop Drawings prepared by the Contractor's Professional Engineer and submitted to and approved by the Program/Project Manager.
 - 1) Provide steel studs complying with the requirements specified in ASTM C 955, and formed from steel complying with the requirements for Grade 50 steel specified in ASTM A 653/A 653M.
 - 2) Provide steel runners (tracks), bridging, and accessories formed from steel complying with the requirements for Grade 33 steel specified in ASTM A 653/A 653M.
 - 3) With each type of framing required, provide the steel runners (tracks), blocking, bridging, bridge clips, lintels, clip angles, shoes, reinforcements, fasteners, and accessories for the application indicated in the approved Shop Drawings and required for a complete metal framing system.
- b. Stud and Joist Shapes:
 - 1) Provide C-shaped studs and joists having minimum 1-1/4 inch flange widths, a stiffened lip.
 - 2) For bridging and blocking, provide studs and joists having punched webs as required for the approved design.
- c. Steel:
 - 1) For 54-mil (16 gage) and heavier units, provide components fabricated from structural quality steel sheet having a minimum yield point of 50,000 psi, and that complies with the requirements specified in ASTM A 653/A 653M, ASTM A 1008/A 1008M, or ASTM A 1011/A 1011M.
 - 2) For 43-mil (18 gage) and lighter units, provide components fabricated from standard commercial quality steel sheet having a minimum yield point of 33,000 psi, and that complies with the requirements specified in ASTM A 653/A 653M, ASTM A 1008/A 1008M, or ASTM A 1011/A 1011M.
- d. Welding Electrodes:
 - 1) Provide welding electrodes as recommended by the stud manufacturer and that comply with the requirements of AWS D1.3.
 - a) Submit letters indicating the welding electrodes qualified for use with each type of stud and joist provided from the stud



and joist manufacturers to the Program/Project Manager for information.

- e. Fasteners:
 - 1) Provide nuts, bolts, washers, screws, and other fasteners that have a corrosion resistant finish.
 - 2) Provide headed type anchor bolts for use in cast-in-place concrete.
 - 3) For manufactured connectors, only provide connectors having a current ICC-ES Evaluation Reports.
 - a) Submit ICC-ES Evaluation Reports for the manufactured connectors proposed for use under this Section to the Program/Project Manager for information.
 - 2. Framing and Furring Members:
 - a. For steel framing and furring members for screw attached gypsum board, provide materials complying with the requirements specified in Section 09260, Gypsum Board Assemblies.
- E. Fabrication:
- 1. Shop Fabrication:
 - a. Jigs:
 - 1) Furnish jig templates to hold members in the proper alignment and position during fabrication so components can be consistently placed.
 - b. Fastening:
 - 1) Attach similar components by welding, bolting, or screw fasteners, whichever is the manufacturer's standard method.
 - 2) Attach dissimilar structural components by bolting or screw fasteners; whichever is the manufacturer's standard method.
 - a) Isolate components made from dissimilar materials from each other to prevent galvanic action.
 - 3) Tying framing components using wire is unacceptable.
 - 2. Fabrication Tolerances:
 - a. Fabricate components within the allowable maximum variation from plumb, level, and true to line of 1/8 inch in 10 feet.
- F. Finishes:
- 1. Primer Materials:
 - a. Provide zinc-oxide or another similar rust-inhibitive primer recommended by the cold-formed metal framing manufacturer and compatible with the galvanized metal framing products provided.
 - 2. Shop Finishing Methods:
 - a. Unless otherwise indicated in the Contract Documents, galvanize cold-formed metal materials in accordance with the requirements for Type H and L products specified in ASTM A 1003/A 1003M, which requires galvanizing complying with the requirements for Coating Designation G60 specified in ASTM A 653/A 653M, for a normal



exposure condition enclosed within a building envelope with a controlled environment.

- b. Shop-apply a prime coat finish consisting of 1 coat of rust-inhibitive primer on the main framing components.
- c. Unless otherwise indicated, finish installation accessories to match the finish of the main framing components.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine areas and substrates to receive cold-formed metal framing for compliance with requirements and other conditions affecting performance.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install cold-formed metal framing systems in accordance with the manufacturer's printed or written instructions and recommendations.
 1. Perform welding using certified welders having experience welding light gage members in accordance with the requirements specified in AWS D1.3 and the AISI standards listed herein.
 - a. Clean welded areas and weld affected areas in accordance with the requirements specified in SSPC-SP 2 or SSPC-SP 3, and coat them with a minimum of 2 coats of zinc-rich paint.
 2. Saw cut metal studs square and true.
 - a. Do not cut studs using a torch.
 3. Do not splice studs or tracks used as a built-up king stud.
 4. Submit installation instructions for each component and accessory proposed for the cold-formed metal framing to the Program/Project Manager for approval.
- B. Runner Tracks:
 1. Install continuous tracks sized to match the studs being installed.
 2. Accurately align the tracks to match the layout at the base and top of the studs.
 3. Secure the tracks as recommended by the stud manufacturer, for the type of construction involved, except comply with the following requirements:
 - a. For nail or power-driven fasteners, do not space the fasteners more than 24 inches apart on center.
 - b. For other than nail or power-driven fasteners, do not space the fasteners more than 16 inches apart on center.



- c. Provide fasteners at the corners and ends of tracks.
- C. Wall Studs:
 - 1. Set studs plumb unless the studs are required for diagonal bracing, non-plumb walls, warped surfaces, or other similar applications.
 - 2. Secure wall studs to the top and bottom runner tracks by either welding or screw fastening at both the inside and outside flanges of the runner tracks.
 - 3. Set studs no more than 16 inches apart on center.
 - 4. For studs at exterior walls, the width and gage are indicated on the Contract Drawings.
 - 5. For studs at interior non-load-bearing partitions, comply with the requirements specified in Section 09260, Gypsum Board Assemblies, and AISI S200 for non-structural studs.
- D. Supplementary Supports:
 - 1. Wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, or similar work requiring attachment to the wall or partition; install supplementary framing, blocking, and bracing in the metal framing system.
 - 2. If the type of supplementary support is not otherwise indicated in the Contract Documents, provide support complying with the manufacturer's recommendations and industry standards, and taking the loading or weight resulting from the item supported into consideration.
- E. Wall Openings:
 - 1. For wall openings larger than 2 feet square, frame the opening with a double stud at each jamb of the frame unless the manufacturer's instructions show or indicate more than 2 studs.
 - 2. Provide runner tracks and jack studs above and below wall openings.
 - a. Anchor the tracks to the jamb studs with stud shoes or by welding, and space the jack studs the same as the full-height studs of the wall.
 - 3. Secure the stud system wall opening frame in the manner indicated herein.
- F. Expansion and Control Joints:
 - 1. Frame both sides of expansion and control joints with separate studs.
 - 2. Do not bridge the joint with components of the stud system.
- G. Horizontal Stiffeners:
 - 1. Provide horizontal stiffeners in the stud system spaced vertically no more than 48 inches apart on center, and attached at each stud intersection.
- H. Special Techniques:
 - 1. Where required to reinforce joists at interior supports, provide a single short length of joist section located directly over the interior support, a



snap-on shoe, a side-piece reinforcement lapped 30 percent, or another method recommended by the joist manufacturer.

- I. Interface with Other Work:
 - 1. Where the stud system abuts structural columns or walls, including masonry walls, anchor the ends of the stiffeners to the supporting structure.
 - 2. Dissimilar Metals:
 - a. Isolate cold-formed metal framing products from contact with dissimilar metals, such as copper or brass, to prevent galvanic action.
- J. Erection Tolerances:
 - 1. Bolt or weld wall panels at both horizontal and vertical junctures so flush, even, true-to-line joints result.
 - 2. Do not allow the variation in plane and true position between prefabricated assemblies exceed 1/16 inch.

3.03 REPAIR

- A. Touch up damaged shop-applied protective coatings using compatible primers for prime-coated surfaces, and a galvanizing repair system for galvanized repair surfaces.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when cold-formed metal framing is being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Both continuous and periodic Special Inspections will be performed during the erection of cold-formed metal framing.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- B. Inspections:



1. Verify that prefabricated assemblies are within the erection tolerances specified herein.
2. Welding and welders are subject to Special Inspections.
3. Connections made with high strength bolts are subject to Special Inspections.
4. Verify that connections have the appropriate number of fasteners as indicated in the approved Shop Drawing plans and details.
5. Verify that dissimilar metals are isolated to prevent galvanic action.

C. Non-Conforming Work

1. Correct deficiencies in the Work that inspections have indicated to be not in compliance with requirements.

3.05 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All.	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.B, 1.04B, 2.01.A, 2.01G	Add requirements for ENVISION Sustainability Rating System



SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following metal fabrications:
 - a. Steel framing and supports for mechanical and electrical equipment.
 - b. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - c. Loose bearing and leveling plates.
 - d. Steel weld plates and angles for casting into concrete not specified in other Sections.
 - e. Miscellaneous metal trim.
 - f. Metal ladders.
 - g. Metal bollards.
 - h. Metal downspout boots.
 - i. Metal platforms.
 - j. Steel edging headers
- B. Products Supplied But Not Installed Under This Section:
 - 1. The following products are furnished under this Section, but are installed under other Sections:
 - a. Loose steel lintels.
 - b. Anchor bolts, steel pipe sleeves, and adhesive and expansion-type inserts indicated to be cast into or post installed into concrete or unit masonry Work.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 03300 - Cast-In Place Concrete.
 - 4. Section 05120 - Structural Steel.
 - 5. Section 05511 – Metal Stairs
 - 6. Section 05520 – Handrails and Railings
 - 7. Section 05530 - Gratings.
 - 8. Section 06105 - Miscellaneous Carpentry.
 - 9. Section 05580 – Formed Metal Fabrications.

1.02 REFERENCES

- A. Abbreviations and Acronyms:



1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Reference Standards:

1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
3. American Institute of Steel Construction (AISC):
 - a. AISC 201 - Certification Program for Structural Steel Fabricators.
4. American National Standards Institute (ANSI):
 - a. ANSI A14.3 – Ladders – Fixed - Safety Requirements.
5. American Society of Mechanical Engineers (ASME):
 - a. ASME B18.2.1 – Square and Hex Bolts and Screws (Inch Series).
 - b. ASME B18.6.3 – Slotted and Recessed Head Machine Screws and Machine Screw Nuts.
 - c. ASME B18.21.1 – Lock Washers (Inch Series).
 - d. ASME B18.22.1 – Plain Washers.
6. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
 - c. AWS D1.3 - Structural Welding Code–Sheet Steel.
 - d. AWS D1.6 - Structural Welding Code–Stainless Steel.
7. ASTM International (ASTM):
 - a. ASTM A 27/A 27M – Standard Specification for Steel Castings, Carbon, for General Application.
 - b. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - c. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
 - d. ASTM A 48/A 48M – Standard Specification for Gray Iron Castings.
 - e. ASTM A 53/A 53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - f. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.



- g. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- h. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
- i. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
- j. ASTM A 489 – Standard Specification for Carbon Steel Lifting Eyes.
- k. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- l. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
- m. ASTM A 563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric].
- n. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
- o. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- p. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- q. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- r. ASTM B 632/B 632M – Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- s. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- t. ASTM C 1107/C 1107M – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- u. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
- v. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- w. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- x. ASTM F 594 - Standard Specification for Stainless Steel Nuts.
- y. ASTM F 1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 8. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 9. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 10. ICC Evaluation Service, Inc. (ICC-ES):
 - a. ICC-ES Reports™ (ESRs), www.icc-es.org/Evaluation_Reports/index.
- 11. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA 500– Metal Finishes Manual for Architectural and Metal Products.



12. The Society for Protective Coatings (SSPC):
 - a. SSPC-PA 1 – Shop, Field and Maintenance Painting.
 - b. SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
 - c. SSPC-Paint 29 – Zinc Dust Sacrificial Primer, Performance-Based.
 - d. SSPC-SP 3 – Power Tool Cleaning.
 - e. SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
13. The Master Painters Institute (MPI):
 - a. MPI # 79 – Primer, Alkyd, Anti-Corrosive for Metal.
14. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
15. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the installation of anchorages for metal fabrications with installation of the metal fabrications.
 - a. 10 days before the metal fabrications are to be installed, give notice to those performing other construction work related to the miscellaneous metal installation, such as to those performing work that must be supported by or that will provide support of the miscellaneous metal, to allow such items to be introduced or furnished before the miscellaneous metal is installed.

B. Scheduling:

1. Coordinate the metal fabrications fabrication schedule with construction progress to avoid delaying the Work.

1.04 SUBMITTALS

A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Shop Drawings showing fabrication and installation details for the proposed metal fabrications.
 - b. Samples:
 - 1) Materials and finished products as may be requested by the Program/Project Manager.
 - c. Delegated Design Submittals:
 - 1) Structural analysis data.
 - d. Qualification Statements:
 - 1) Welding procedure qualification test records (PQRs).
 - 2) Welding procedure specifications (WPSs).
 - 3) Welding Certificates.
 - 4) Fabricator Qualifications.
 - 5) Professional Engineer's credentials.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) ICC-ES Reports for expansion and adhesive anchors.
 - b. Manufacturer's Instructions:
 - 1) Expansion and adhesive anchor manufacturers' installation recommendations.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Material
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. At least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied primer.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.



- b. Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
- 2. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Qualifications:

- 1. Fabricator's Qualifications:
 - a. Employ a firm experienced in producing metal fabrications similar to those indicated for this Contract, who is either AISC-certified in accordance with the requirements specified in AISC 201 or listed in the current City of Phoenix approved fabricators list with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.
 - 1) Submit Fabricator Qualifications to demonstrate the capabilities and experience of the Fabricator, including a list of completed projects with project name, addresses, names of designers and owners, and other information applicable.
- 2. Professional Engineer's Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform structural analysis required for the metal fabrication.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.
- 3. Welding Qualifications:
 - a. Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.
 - 1) For all procedures, other than those set forth in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and AWS D1.6, submit a copy of the welding procedure qualification test records (PQRs) and welding procedure specifications (WPSs) to the Program/Project Manager for approval.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and/or AWS D1.6, for the procedures.
 - 1) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been certified in accordance with American Welding Society (AWS) standards within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the



required welding procedures and, if pertinent, has undergone recertification.

C. Site Samples:

1. Submit Samples representative of the materials and finished products as may be requested by the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Coordinate delivery to the Site of anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages.
2. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.

B. Storage and Handling Requirements:

1. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.

PART 2 PRODUCTS

2.01 METAL FABRICATIONS

A. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments and the ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. Ladders:
 - 1) Fabricate ladders in accordance with the requirements specified in 29 CFR 1910.27 Fixed Ladders, and 29 CFR 1926.1053 Ladders.
2. Sustainability Requirements:
 - a. Recycled Content
 - 1) Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
 - b. Low Emitting Materials – Paints and Coatings
 - 1) When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.

B. Design Criteria:



1. Form metal fabrications from materials of the size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated.
 - a. Work to the dimensions indicated or approved on Shop Drawings, using proven details of fabrication and support.
 - b. Use the type of materials indicated or specified for the various components of each metal fabrication.
 - c. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
2. Thermal Movement:
 - a. To prevent buckling, opening up of joints, and overstressing of welds and fasteners, during the design, fabrication, and installation of installed metal assemblies allow for thermal movement resulting from a maximum temperature change (range) of 100 deg Fahrenheit (55.5 deg Celsius) in the ambient temperature.
 - b. Base design calculations on the actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
3. Metal Surfaces:
 - a. For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes.
 - b. Do not use materials with exposed pitting, scam marks, roller marks, rotted trade names, or roughness.
4. Fasteners:
 - a. Select fasteners of the type, grade, and class required.
 - b. Unless otherwise indicated in the Contract Documents, provide the following types of fasteners for metal fabrications:
 - 1) For exterior walls, provide Type 304 stainless steel bolts and fasteners.
 - 2) For interior walls, provide fasteners and bolts zinc-plated in accordance with the requirements for Class Fe/Zn 5 coating specified in ASTM B 633.
 - 3) For fastening aluminum, provide stainless steel fasteners.
 - c. Expansion Anchors:
 - 1) For non-structural applications, provide expansion anchor bolt and sleeve assemblies with the capability to sustain, without failure, the following loads as determined by testing conducted by a qualified independent testing agency in accordance with the requirements specified in ASTM E 488:
 - a) When installed in unit masonry, a load equal to 6 times the load imposed.
 - b) When installed in concrete, a load equal to 4 times the load imposed.
 - 2) For non-structural applications, provide minimum expansion anchor embedment equal to 8 times the anchor diameter unless calculations from a registered Professional Engineer are provided.



- 3) For structural applications, provide expansion anchor bolt and sleeve assemblies as specified in the structural Sections and indicated on the Contract Drawings.
 - d. Adhesive Anchors:
 - 1) For structural applications, provide adhesive anchors as specified in the structural Sections and indicated on the Contract Drawings.
 - e. Provide expansion and adhesive anchors having ICC-ES Reports™ (ESRs) showing they comply with the applicable codes.
 - 1) Submit the ICC-ES Reports for the anchors to the Program/Project Manager for information.
 - 5. Shop Drawings:
 - a. Submit Shop Drawings showing fabrication and installation details for the proposed metal fabrications to the Program/Project Manager for approval.
 - 1) Include plans, elevations, sections, and details of metal fabrications and their connections
 - 2) Show anchorage and accessory items.
 - 3) Submit setting drawings, diagrams, templates, instructions, and directions for installing anchorages.
 - a) Provide templates for anchors and bolts specified for installation under other Sections.
 - 6. Calculations:
 - a. For installed products indicated to comply with design loads, submit structural analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation to the Program/Project Manager for approval.
- C. Materials
- 1. Ferrous Metals:
 - a. Structural Steel:
 - 1) For structural steel framing system components, provide materials complying with the requirements specified in Section 05120, Structural Steel.
 - b. Steel Plates, Shapes, and Bars:
 - 1) Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - c. Stainless Steel Sheet, Strip, Plate, and Flat Bars:
 - 1) Provide stainless steel sheet, strip, plate, and flat bars complying with the requirements for Type 304 stainless steel specified in ASTM A 666.
 - a) Perforations:
 - (1) Where required, provide custom perforations as indicated in the Contract Drawings.
 - (a) Provide straight-line 1/8 inch by 3/4 inch slots, 40 percent open.
 - b) Finish:



- (1) Provide a bright, directional satin finish: No. 4, unless otherwise specified.
- d. Stainless Steel Bars and Shapes:
 - 1) Provide stainless steel bars and shapes complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- e. Steel Tubing:
 - 1) Provide cold-formed steel tubing complying with the requirements specified in ASTM A 500
- f. Steel Pipe:
 - 1) Provide standard weight (schedule 40) steel pipe complying with the requirements specified in ASTM A 53/A 53M, unless otherwise indicated in the Contract Documents or another weight required by structural loads.
- g. Cast Iron:
 - 1) Provide Class 30 cast iron pipe complying with the requirements specified in ASTM A 48/A 48M, unless otherwise indicated in the Contract Documents or another weight required by structural loads.
2. Nonferrous Metals:
 - a. Aluminum Plate and Sheet:
 - 1) Provide Alloy 6061-T6 aluminum plate and sheet complying with the requirements specified in ASTM B 209.
 - b. Aluminum Extrusions:
 - 1) Provide Alloy 6063-T6 aluminum extrusions complying with the requirements specified in ASTM B 221.
 - c. Aluminum-Alloy Rolled Tread Plates:
 - 1) Provide Alloy 6061-T6 aluminum-alloy rolled tread plates complying with the requirements specified in ASTM B 632/B 632M.
3. Fasteners:
 - a. Bolts and Nuts:
 - 1) Provide regular hexagon-head steel bolts complying with the requirements specified for Grade A bolts in ASTM A 307.
 - 2) Provide steel hex nuts complying with the requirements specified in ASTM A 563 (ASTM A 563M).
 - 3) Provide steel flat washers where indicated in the Contract Documents.
 - b. Anchor Bolts:
 - 1) Provide Grade 36 anchor bolts complying with the requirements specified in ASTM F 1554.
 - c. Eyebolts:
 - 1) Provide eyebolts complying with the requirements specified in ASTM A 489.
 - d. Machine Screws:



- 1) Provide machine screws complying with the requirements specified in ASME B18.6.3.
 - e. Lag Bolts:
 - 1) Provide lag bolts complying with the requirements specified in ASME B18.2.1.
 - f. Plain Washers:
 - 1) Provide plain round washers complying with the requirements specified in ASME B18.22.1.
 - g. Lock Washers:
 - 1) Provide helical, spring type lock washers complying with the requirements specified in ASME B18.21.1.
 - h. Cast-in-Place Anchors in Concrete:
 - 1) Provide anchors capable of sustaining, without failure, a load equal to 4 times the load imposed as determined by testing conducted by a qualified independent testing agency in accordance with the requirements specified in ASTM E 488.
 - 2) Provide either threaded or wedge type anchors.
 - 3) Provide galvanized ferrous castings, either malleable iron castings complying with the requirements specified in ASTM A 47/A 47M, or cast steel castings complying with the requirements specified in ASTM A 27/A 27M.
 - 4) Provide bolts, washers, and shims as required, hot-dip galvanized in accordance with the requirements specified in ASTM A 153/A 153M.
 - i. Expansion Anchors:
 - 1) For non-structural applications in interior locations, provide carbon steel expansion anchors zinc-plated in accordance with the requirements for Class Fe/Zn 5 coating specified in ASTM B 633.
 - 2) For non-structural applications in exterior locations, provide expansion anchors having Alloy Group 1 stainless steel bolts complying with the requirements specified in ASTM F 593, and stainless-steel nuts complying with the requirements specified in ASTM F 594.
 4. Gratings:
 - a. Provide metal bar gratings and anchors, and metal frames and supports for the gratings in accordance with the requirements specified in Section 05530, Gratings.
- D. Components
1. Aluminum Ladders:
 - a. Fabricate ladders for the locations shown from aluminum Alloy 6063-T6 having a mill finish, and with the dimensions, spacing, details, and anchorages indicated on the Contract Drawings.
 - 1) If the dimensions, spacing, details, and anchorages are not indicated on the Contract Drawings, fabricate ladders in accordance with the requirements specified in ANSI A14.3 and



this Section, and submit Shop Drawings showing the proposed design to the Program/Project Manager for approval.

b. Caged Access Ladders:

1) Side Rails:

- a) Provide continuous side rails fabricated from 1-3/4-inch (45mm) by 3-inch (76mm) aluminum tube with a 1/8-inch wall thickness, and having eased edges, and spaced 24 inches (610mm) apart.
- b) Extend the side rails 42 inches (1.1m) above the top rung, and return the rails to the wall or structure, unless other secure handholds are provided.

2) Rungs:

- a) Provide rungs fabricated from 1-1/4-inch square aluminum tube with corrugated surfaces spaced 12 inches (310mm) apart on center.
- b) Fit and locate the rungs on the centerline of the side rails.
- c) Plug weld and grind smooth the bar rungs on outer side rail faces.
- d) Provide nonslip corrugated surfaces on each rung.

3) Intermediate Platforms:

- a) If indicated on the Contract Drawings, provide intermediate crossover platforms.

(1) Treads:

- (a) Provide platform treads fabricated from 6-inch (152mm) wide by 1-3/4-inch (45mm) deep aluminum treads having a corrugated surface.

(2) Platform Frames:

- (a) Provide frames for the intermediate crossover platforms fabricated from 5-inch (127mm) aluminum channels.

(3) Guardrails:

- (a) Provide guardrails at the intermediate crossover platforms fabricated from 1-1/4-inch square aluminum tube with corrugated surfaces.
- (b) Provide 42-inch high guardrails connected to the side rails of 2 ladder segments as detailed on the Contract Drawings and approved Shop Drawings.

4) Safety Cages:

- a) If indicated on the Contract Drawings, provide safety cages for the ladders fabricated from 2-inch wide by 1/4-inch thick aluminum vertical strips and horizontal hoops welded together to form a cage around the ladder as detailed on the Contract Drawings and approved Shop Drawings.
- b) Provide at least 27 inches of clearance from the ladder to the back of the cage.



- c) Locate the bottom of the cage 7 feet above grade or 7 feet above the closest intermediate platform below the cage.
 - d) Extend the safety cages at least 42 inches (1.1m) above the top rung, and attach the extension to the side rails as detailed on the Contract Drawings and approved Shop Drawings.
 - 5) Safety Post Extensions:
 - a) For fixed ladders, provide safety post extensions fabricated from tubular aluminum sections, and having adjustable mounting brackets designed to be attached to the top of the ladder.
 - b) Design the safety post extensions for manual operation, and provide a mechanism consisting of a mechanical pin for locking the safety post in place when it has been fully extended.
 - 6) Support Brackets:
 - a) Wall Brackets:
 - (1) Provide wall brackets fabricated from flat bar aluminum at least 2 inches (50mm) wide by 1/4-inches (6mm) thick.
 - b) Floor Brackets:
 - (1) Provide floor brackets fabricated from flat bar aluminum at least 2 inches (50mm) wide by 1/4-inches (6mm) thick to anchor the side rails to the floor.
 - c) Allow at least 7 inches (180mm) clearance from the wall to the center line of the rungs.
 - 7) Manufacturers:
 - a) ACL Industries, Inc., Model ACL-390A,
<http://www.aclindustries.com>.
 - b) Approved equal.
- 2. Steel Ladders:
 - a. Fabricate ladders for the locations shown from steel with the dimensions, spacing, details, and anchorages indicated on the Contract Drawings.
 - 1) If the dimensions, spacing, details, and anchorages are not indicated on the Contract Drawings, fabricate ladders in accordance with the requirements specified in ANSI A14.3 and this Section, and submit Shop Drawings showing the proposed design to the Program/Project Manager for approval.
 - b. Side Rails:
 - 1) Provide continuous side rails fabricated from 1/2-inch (12mm) by 2-1/2-inch (64mm) flat steel bar having eased edges, and spaced 18 inches (460 mm) apart.
 - 2) Extend the side rails 42 inches (1.1m) above the top rung, and return the rails to the wall or structure, unless other secure handholds are provided.
 - c. Rungs:



- 1) Provide rungs fabricated from 3/4-inch (19mm) diameter steel bar spaced 12 inches (310mm) apart on center.
 - 2) Fit and locate the rungs on the centerline of the side rails.
 - 3) Plug weld and grind smooth the bar rungs on outer side rail faces.
 - 4) Provide nonslip surfaces on the top of each rung.
 - d. Support Brackets:
 - 1) Provide welded or bolted steel brackets to support each ladder at the top and bottom, and at intermediate points spaced not more than 5 feet (1.5m) apart on center.
 - a) Size the brackets to support the design dead and live loads indicated in the Contract Documents, and to hold the centerline of the ladder rungs clear of the wall surface by not less than 7 inches (180mm).
 - (1) If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
3. Loose Lintels:
 - a. Provide loose lintels fabricated from steel angles and shapes of the sizes indicated in the Contract Documents for the openings and recesses in masonry walls and partitions, and at the locations indicated in the Contract Documents.
 - b. Weld adjoining members together to form a single unit where indicated in the Contract Documents.
 - c. Size the loose lintels so equal bearing is provided at each end of the lintel as follows:
 - 1) For spans up to 6 feet, provide 4 inches of bearing at each end.
 - 2) For spans between 6 and 10 feet, provide 8 inches of bearing at each end.
 - 3) For spans greater than 10 feet, if any, provide an equal bearing of 1 inch per foot of clear span at each side of openings, unless otherwise indicated in the Contract Documents.
4. Loose Bearing and Leveling Plates:
 - a. For steel items bearing on masonry or concrete construction, provide loose bearing and leveling plates fabricated so they are flat, free from warps or twists, and of the required thickness and bearing area.
 - b. Drill the loose bearing and leveling plates to receive anchor bolts, and for grouting as required.
 - c. After fabrication, galvanize the loose bearing and leveling plates.
5. Miscellaneous Framing and Supports:
 - a. Provide steel framing and supports for the applications indicated in the Contract Documents that are not a part of structural steel framework and not specified in other Sections as required to complete the Work.
 - b. Fabricate units to the sizes, shapes, and profiles indicated in the Construction Documents, and as required to receive adjacent construction retained by framing and supports.



- 1) Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of welded construction using mitered joints for field connection.
- 2) Cut, drill, and tap units to receive hardware, hangers, and similar items.
- c. Attachments:
 - 1) Equip units with integrally welded anchors for casting into concrete or building into masonry.
 - a) If units must be installed after concrete is placed, provide inserts.
 - b) Provide anchor units consisting of 1-1/4-inch (32mm) wide by 8-inch (200mm) long by 1/4-inch (6mm) thick steel straps, minimum.
 - d. Galvanize miscellaneous framing and supports where indicated in the Construction Documents.
 - e. Prime miscellaneous framing and supports with zinc-rich primer where indicated in the Construction Documents.
6. Miscellaneous Metal Trim:
 - a. Formed Metal Fabrications:
 - 1) Formed metal fabrications including, but not limited to, the following are specified in Section 05580, Formed Metal Fabrications:
 - a) Metal panel cladding.
 - b) Metal panel beam wraps.
 - c) Metal column covers.
 - d) Baggage cart protection rails.
 - e) Corner guards.
 - f) Metal base.
 - g) Break metal shapes.
 - h) Metal panel escalator cladding.
 - i) Metal panel soffits and bulkheads.
 - b. Unless otherwise indicated, fabricate miscellaneous trim units from structural steel shape, plates, and bars of the profiles shown in the Construction Drawings with continuously welded joints, and smooth exposed edges.
 - 1) Miter the corners, and use concealed field splices wherever possible.
 - c. Provide cutouts, fittings, and anchorages as required to coordinate assembly and installation of miscellaneous trim units with other work.
 - d. For embedding miscellaneous trim in concrete or masonry construction, weld anchors to the trim.
 - 1) Space the anchors not more than 6 inches (150mm) from each end, 6 inches (150mm) from corners, and 24 inches (600mm) apart on center, unless otherwise indicated in the Construction Documents.
 7. Metal Bollards:



- a. Fabricate metal bollards from Schedule 80 steel pipe.
 - b. Fill bollards with concrete mounding to the surface.
 - c. For anchoring bollards, provide sleeves fabricated from steel pipe having a 1/4-inch (6.4mm) thick steel base plate welded to the bottom of the pipe.
8. Metal Downspout Boots:
 - a. Provide metal downspout boots fabricated from cast gray iron in the lengths indicated in the Contract Documents.
 - 1) Provide inlets of a size and shape to suit the downspouts.
 - 2) Provide vertical outlets to discharge onto splash blocks or pavement.
 - b. Finish the downspout boots to match the finish color of the adjacent materials.
9. Rough Hardware:
 - a. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.
 - 1) Straight bolts and other stock rough hardware items are specified in Section 06105, Miscellaneous Carpentry.
 - b. Fabricate items to the sizes, shapes, and dimensions required.
 - 1) Furnish malleable-iron washers for heads and outs that bear a wood structural connection, and furnish steel washers elsewhere.
10. Rain Water Pipe Attachment Straps:
 - a. Provide stainless steel rain water pipe attachment straps complying with the requirements for Type 304 stainless steel or Type 316 stainless steel specified in ASTM A 666.
11. Roof Drain Leaders – Exposed
 - a. Unless otherwise indicated, fabricate exposed roof drain leaders from structural steel shape, plates, tubes and bars of the profiles shown in the Construction Documents with continuously welded joints, and smooth exposed edges.
 - b. Provide cutouts, fittings, and anchorages as required to coordinate assembly and installation of drain leaders with other work.
 - c. For embedding sleeves in concrete construction, weld anchors to the trim.
 - 1) Space the anchors not more than 6 inches from each end, 6 inches from corners, and 24 inches apart on center, unless otherwise indicated in the Construction Documents.
 - d. Weld tabs to frames and coordinate with fireproofing and finishing of the AECS.
 - e. Deliver components to site shop primed for field applied high performance coating.
12. Roof Drain Downspout Nozzle – Exposed



- a. Fabricate exposed roof drain downspout nozzles from cast nickel bronze with anchor flange, countersunk mounting holes, and IPS threaded (standard), no hub, or push-on connection.
 - 1) Manufacturers:
 - a) Watts, www.watts.com
 - b) Zurn, www.zurn.com

2.02 ASSEMBLY/FABRICATION:

A. Factory Assembly:

1. Preassemble items in the shop to the greatest extent possible.
2. Disassemble units only as necessary for shipping and handling limitations.
3. Provide connections that maintain the structural value of the joined pieces.
4. Clearly mark units for reassembly and coordinated installation.
5. Prevent galvanic corrosion by preventing dissimilar metals from contacting each other.

B. Shop Fabrication:

1. Shear and punch metals cleanly and accurately, and remove burrs.
2. Unless otherwise indicated in the Contract Documents, ease exposed edges to a radius of approximately 1/32 inch (1mm).
3. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.
4. Remove sharp or rough areas on exposed traffic surfaces.
5. Weld corners and seams continuously, and comply with the following requirements:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of the base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and the contour of the welded surface matches those adjacent.
6. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible.
 - a. Provide exposed fasteners of the type Indicated, or if not indicated, Phillips flat-head (countersunk) screws or bolts.
 - b. Locate joints where least conspicuous.
7. Provide an anchorage of the type indicated in the Contract Documents.
 - a. Coordinate the anchorage with the supporting structure.
 - b. Fabricate and space anchoring devices to secure the metal fabrication rigidly in place, and to support the indicated loads.
 - c. For exterior applications, provide either Type 304 stainless steel or hot-dipped galvanized anchorages.
8. Cut, reinforce, drill, and tap the metal fabrications as indicated to receive finish hardware, screws, and similar items.



9. Fabricate joints that will be exposed to the weather so water is excluded, or provide weep holes where water may accumulate.
10. Factory-apply protective coatings to aluminum surfaces that will come into direct contact with concrete, cement grout materials, or other dissimilar materials that would cause galvanic corrosion of the metal.

2.03 MIXES:

A. Concrete Materials and Properties:

1. Provide concrete materials complying with the requirements specified in Section 03300, Cast-in-Place Concrete, for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20MPa), unless higher strengths are indicated.

B. Nonshrink, Nonmetallic Grout:

1. Provide factory-packaged, non-ferrous-aggregate nonshrink grout complying with the requirements specified in ASTM C 1107/C 1107M, having a minimum 28-day strength of 7000 psi, and having a flowable or plastic consistency; or provide other nonshrink grout specifically recommended by the equipment manufacturer for heavy-duty loading applications.

2.04 FINISHES:

A. Primer Materials:

1. Shop Primers:
 - a. Where applicable, provide shop primers complying with the requirements specified in the appropriate Division 9 Sections.
2. Universal Shop Primer:
 - a. Provide fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with the requirements specified in MPI # 79.
3. Zinc-Rich Primer:
 - a. Provide Type II zinc-rich primer complying with the requirements specified in SSPC–Paint 20 or SSPC–Paint 29, and compatible with the topcoat.
 - b. Provide primer having a VOC content of 3.5 pounds per gallon or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
 - c. Manufacturers:
 - 1) International Protective Coatings, Interzinc® 315 Epoxy Zinc-Rich Primer, <http://www.international-pc.com/>.
 - 2) Sherwin-Williams Company, Corothane I GalvaPac Zinc Primer, www.sherwin-williams.com.
 - 3) Tnemec Company, Inc., Tneme-Zinc 90-97, www.tnemec.com.
 - 4) Approved equal.
4. Galvanizing Repair Paint:



- a. For re-galvanizing welds in steel, provide high-zinc-dust-content paint complying with the requirements specified in SSPC-Paint 20.
 - b. Apply 2 coats.
 5. Bituminous Paint:
 - a. Provide a cold-applied asphalt emulsion complying with the requirements specified in ASTM D 1187.
- B. Finish Materials:
 1. Galvanizing:
 - a. For galvanizing steel and iron products, except hardware, provide galvanizing complying with the requirements specified in ASTM A 123/A 123M.
 - b. For galvanizing steel and iron hardware, provide galvanizing complying with the requirements specified in ASTM A 153/A 153M.
 2. Aluminum Finishes:
 - a. As-Fabricated Finish:
 - 1) Provide an AA-M10 finish (mechanical finish: as fabricated, unspecified) complying with the requirements specified in AA DAF-45.
 - b. Class I, Clear Anodic Finish:
 - 1) Provide an AA-M12C22A41 finish (mechanical finish: nonspecular as fabricated) complying with the requirements specified in AA DAF-45.
 - c. Chemical Finish:
 - 1) Provide an etched, medium matte finish.
 - d. Anodic Coating:
 - 1) Provide an Architectural Class I finish (clear coating 0.018mm or thicker) complying with the requirements specified in AAMA 611.
- C. Shop Finishing Methods:
 1. For recommendations relative to applying and designing finishes, comply with the recommendations specified in NAAMM/NOMMA 500.
 2. Finish metal fabrications after assembly.
 3. Galvanize exterior and interior miscellaneous steel trim where indicated in the Contact Documents.
 4. Prime exterior and interior miscellaneous steel trim with zinc-rich primer where indicated in the Contact Documents.
 5. Preparation for Shop Priming:
 - a. Prepare ferrous metal surfaces to comply with the minimum SSPC surface preparation requirements specified, and for the environmental exposure conditions of the installed metal fabrications.
 - 1) For interiors (SSPC Zone 1A), prepare the surface in accordance with the requirements specified in SSPC-SP 3.
 - 2) For exteriors (SSPC Zone 1B) and items to receive zinc-rich primer, prepare the surface in accordance with the requirements specified in SSPC-SP 6.



6. Unless otherwise indicated in the Contract Documents, apply shop primer to uncoated surfaces of the metal fabrications in accordance with the requirements specified in SSPC-PA 1 for shop painting, except for the following surfaces:
 - a. Uncoated surfaces with galvanized finishes.
 - b. Uncoated surfaces to be embedded in concrete, sprayed-on fireproofing, or masonry.

2.05 ACCESSORIES

- A. Welding Rods and Bare Electrodes:
 1. Provide welding rods and bare electrodes selected according to the American Welding Society (AWS) specifications for the metal alloy to be welded.
- B. Metal Stairs:
 1. For metal framed stairs with metal pan, metal plate, or grating treads, provide metal stairs complying with the requirements specified in Section 05511, Metal Stairs.
- C. Handrails and Railings:
 1. For metal pipe and tube handrails and railing systems, provide handrails and railings complying with the requirements specified in Section 05520, Handrails and Railings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Field Measurements:
 - a. Check actual locations of walls and other construction to which metal fabrications must fit by making accurate field measurements before fabricating the metal fabrications.
 - 1) Show recorded measurements on the final Shop Drawings.
 - b. Where field measurements cannot be made without delaying the Work, guarantee dimensions, and proceed with fabricating products without field measurements.
 - 1) Coordinate construction to ensure that actual dimensions correspond to the guaranteed dimensions.
 - 2) Allow for trimming and fitting.

3.02 PREPARATION

- A. Surface Preparation:
 1. Provide anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.



- a. Set sleeves in concrete with their tops flush with the finish surface elevations.
 - 1) Prevent water and concrete from entering the sleeves.
- b. Install expansion and adhesive anchors in accordance with the manufacturer's recommendations and ICC-ES Report requirements.
 - 1) Submit the expansion and adhesive anchor manufacturers' installation recommendations to the Program/Project Manager for information.

3.03 INSTALLATION

- A. Cutting, Fitting, and Placement:
 1. Cut, drill, and fit miscellaneous metal fabrications as required for installation.
 2. Accurately set the metal fabrications in the proper location, in the proper alignment, and at the proper elevation when measured from established lines and levels, with edges and surfaces level, plumb, true, and free of rack.
- B. Connections:
 1. Fit exposed connections accurately together to form hairline joints.
 2. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations.
 3. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- C. Field Welding:
 1. Provide materials and employ methods that minimize distortion and develop the strength and corrosion resistance of the base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and the contour of welded surface matches those adjacent.
- D. Special Techniques:
 1. Installing Miscellaneous Metal Framing and Supports:
 - a. Install framing and supports to comply with the requirements of the items being supported as indicated in the manufacturer's written instructions and the requirements indicated in approved Shop Drawings.
 2. Installing Bearing and Leveling Plates:
 - a. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen the surfaces to improve bond to surfaces.



- b. Check aluminum materials that are to be mounted on concrete, masonry, or other similar materials to verify that factory-applied coatings to prevent galvanic corrosion have not been damaged.
 - 1) If these coatings have been damaged or are missing, apply material approved by the manufacturer to repair the damage or protect the aluminum materials from corrosion.
 - c. Clean bottom surface of bearing plates, but do not remove protective coatings applied to prevent corrosion.
 - d. Set loose leveling and bearing plates on wedges, shims, or leveling nuts.
 - e. After the bearing members have been positioned and plumbed, tighten the anchor bolts.
 - f. Do not remove wedges or shims, but if they protrude, cut them off flush with the edge of the bearing plate before packing the plates with grout.
 - 1) In concealed locations not exposed to moisture, provide nonshrink grout, either metallic or nonmetallic.
 - 2) In exposed locations; unless otherwise indicated provide nonshrink, nonmetallic grout.
 - 3) Pack the grout solidly between the bearing surfaces and the plates so no voids remain.
 - 3. Installing Metal Bollards:
 - a. Anchor bollards in concrete with pipe sleeves preset and anchored into the concrete.
 - b. After the bollards have been inserted into the sleeves, fill the annular space between bollards and sleeves solidly with nonshrink, nonmetallic grout, mixed and placed in accordance with the grout manufacturer's directions.
 - c. Fill the bollards solidly with concrete.
 - 1) Mound top surface of uncapped bollards so the bollard will shed water.
 - 2) Allow the concrete to cure for 7 days before installing metal caps on capped bollards.
 - 4. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- E. Interface with Other Work:
 - 1. Fastening to In-Place Construction:
 - a. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction.
 - b. Provide threaded fasteners for concrete and masonry inserts, toggle bolts, through-belts, lag bolts, wood screws, and other connectors as required.
 - c. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry or similar construction.

3.04 REPAIR/RESTORATION

A. Touchup Painting:



1. Clean field welds, bolted connections, and abraded areas of shop paint; and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
2. Apply by brush or spray to provide a 2.0-mil (0.05mm) minimum dry film thickness.

B. Galvanized Surfaces:

1. Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with the requirements of ASTM A 780

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when metal fabrications are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Both continuous and periodic Special Inspections will be performed during the installation of post installed anchors for mounting ladders, platforms, safety cages, and other safety related devices or similar fabricated items used for access.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

3.06 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/201	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.1, 1.02.B.15, 1.04.B.2, 2.01.A	Add requirements for ENVISION Sustainability Rating System



SECTION 05511

METAL STAIRS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for preassembled steel stairs with concrete-filled treads.
 - 2. Requirements for steel tube railings attached to metal stairs.
- B. Products Supplied But Not Installed Under This Section:
 - 1. Anchor and Bolt Templates:
 - a. Templates for the anchors and bolts which will be installed under other Sections, but which are required for the installation of the metal stairs provided under this Section, are included under this Section.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 - Cast-In-Place Concrete.
 - 5. Section 03410 - Plant-Precast Structural Concrete.
 - 6. Section 05521 - Pipe and Tube Railings.
 - 7. Section 09912 – Painting.
 - 8. Section 09960 - High-Performance Coatings.
 - 9. Section 16130 – Raceway and Boxes
 - 10. Section 16521 – Exterior Lighting

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.



C. Reference Standards:

1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME):
 - a. ASME B18.2.1 – Square and Hex Bolts and Screws (Inch Series).
 - b. ASME B18.6.3 – Slotted and Recessed Head Machine Screws and Machine Screw Nuts.
 - c. ASME B18.21.1 – Lock Washers (Inch Series).
 - d. ASME B18.22.1 – Plain Washers.
3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - b. AWS D1.3; Structural Welding Code - Sheet Steel.
4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
 - c. ASTM A 48/A 48M – Standard Specification for Gray Iron Castings.
 - d. ASTM A 82/A 82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - e. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - g. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - h. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - i. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - j. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - k. ASTM A 510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - l. ASTM A 510M - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel [Metric].
 - m. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - n. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - o. ASTM A 563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric].
 - p. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.



- q. ASTM A 786/A 786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy Steel Floor Plates.
- r. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
- s. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- t. ASTM A 1018/A 1018M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- u. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- v. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- w. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- x. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
- y. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- z. ASTM F 594 - Standard Specification for Stainless Steel Nuts.
- aa. ASTM F 1267 - Standard Specification for Metal, Expanded, Steel.
- bb. ASTM F 1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- cc. ASTM F 1941 - Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw threads(UN/UNR)).
- dd. ASTM F 1941M - Standard Specification for Electrodeposited Coatings on Threaded Fasteners [Metric].
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. The Master Painters Institute (MPI):
 - a. MPI # 79 - Primer, Alkyd, Anti-Corrosive for Metal.
- 8. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
 - 2) NAAMM AMP 510 - Metal Stairs Manual [*out of print; being revised*].



- b. Metal Bar Grating Division (MBG):
 - 1) ANSI/NAAMM MBG 531 - Metal Bar Grating Manual.
- 9. National Ornamental and Miscellaneous Metals Association (NOMMA):
 - a. NOMMA Voluntary Joint Finish Standards.
- 10. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
 - 2) SSPC-SP 3 - Surface Preparation Specification No. 3 Power Tool Cleaning.
 - 3) SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
- 11. Institute for Sustainability Infrastructure (ISI):
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. Coordinate the locations of hanger rods and struts with other work so they will not encroach on required stair widths, and will be within the fire-resistance-rated stair enclosure.
- B. Sequencing:
 - 1. Sequence the erection of metal stairs to follow construction of supporting concrete and masonry load bearing walls and concrete foundations.
 - 2. Deliver sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry so they can be incorporated into the Work in time to not delay the Work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Prefilled metal-pan stair treads.
 - 2) Nonslip aggregates and nonslip-aggregate finishes.
 - 3) Abrasive nosings.



- 4) Paint products.
 - 5) Conduit
 - 6) Light Fixtures
 - b. Shop Drawings:
 - 1) Metal stair and railing systems.
 - c. Samples:
 - 1) Samples for the initial selection of colors, textures, or designs for those products requiring selections to be made.
 - d. Certificates:
 - 1) Recycled steel content affidavit.
 - e. Delegated Design Submittals:
 - 1) Structural design for the metal stair and railing system.
 - f. Qualification Statements:
 - 1) Professional Engineer's qualifications.
 - 2) Welding procedure specifications (WPS) test records.
 - 3) Welding Certificates.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied primer

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - b. If required by the Authorities Having Jurisdiction (AHJ), submit the necessary engineering data to the AHJ to obtain a separate permit for the Work of this Section.
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of metal stairs.
 - b. Code-Required Approved Agency for Performing Special Inspections:



- 1) To perform the Special Inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered Special Inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 1. Metal Stair Installer's Qualifications:
 - a. Employ the fabricator of the metal stairs to install the stairs.
 2. Professional Engineer's Qualifications:
 - a. Employ a qualified Professional Engineer licensed in the State of Arizona, and capable of performing testing and engineering analysis of the manufacturer's standard units in assemblies similar to those proposed for the Work of this Contract in order to prepare a complete structural design for the metal stair and railing system Work required under this Contract.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.
 3. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.3, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welder Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M and AWS D1.3 for the procedures to be used.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.



- a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- C. Site Samples:
 - 1. For the initial selection of colors, textures, or designs for those products requiring selections to be made, prepare Samples; and submit the Samples to the Program/Project Manager so the selections can be made.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 - 1. Store metal stairs on blocking or other supports to prevent contact with dirt, debris, and moisture.
 - a. Protect metal stairs from exposure to conditions that produce rust.
 - 2. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
 - 3. Handle metal stairs so no parts are bent, broken, or otherwise damaged; and avoid damage to other material and work.
 - a. Exercise care to avoid scraping and over stressing the steel.
 - b. Replace bent or damaged pieces, unless the Program/Project Manager authorizes repairs.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 STAIR ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Steel-Framed Stairs:
 - 1) Alfab, Inc., www.alfabinc.com
 - 2) American Stairs, Inc., www.americanstair.com.



- 3) Sharon Stairs, www.sharonstair.com.
 - 4) Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Sustainability Requirements:
 1. Recycled Content
 - a. Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
 2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.
- C. Performance:
 1. Structural Performance of Stairs:
 - a. Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and under the conditions indicated:
 - 1) Uniform Load: 100 pounds force per square foot (4.79kN/m²).
 - 2) Concentrated Load: 300 pounds force (1.33kN) applied on an area of 4 square inches (2580mm²).
 - 3) Uniform and concentrated loads need not be assumed to act concurrently.
 - b. Stair Framing:
 - 1) Provide metal stair framing capable of withstanding the stresses resulting from railing loads in addition to the loads specified in Subparagraph 2.01.C.1.a.
 - c. Limit the deflection of the stair treads, platforms, and framing members to L/360 or 1/4 inch (6.4mm), whichever is less.
 - d. Shall incorporate electrical conduit for stair mounted light fixtures.
 2. Structural Performance of Stair Railings:
 - a. Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and under the conditions indicated:
 - 1) Handrails and Top Rails of Guards:
 - a) Uniform Load: 50 pounds force per foot (0.73kN/m) applied in any direction.
 - b) Concentrated Load: 200 pounds force (0.89kN) applied in any direction.
 - c) Uniform and concentrated loads need not be assumed to act concurrently.
 - 2) Infill of Guards:



- a) Concentrated Load: 50 pounds force per square foot (2.39kN/m²) applied horizontally.
 - b) Uniform Load: 25 pounds force per foot (0.36kN/m) applied in any direction.
 - c) Infill load and other loads need not be assumed to act concurrently.
 - 3. Seismic Performance:
 - a. Provide metal stairs capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1) The Component Importance Factor to use is 1.5.
 - 4. Lighting Performance:
 - a. Provide lighting on stairwell to meet minimum 5 foot-candle average, 10 to 1 avg/min. Lighting shall include stairs, landings, and 5' from last stair both at top and bottom.
 - b. LED light fixtures with color temperature of 4000K specified in Section 16521 – Exterior Lighting.
- D. Design Criteria:
- 1. Structural Design:
 - a. Furnish a complete structural design for the metal stair and railing system prepared by the Professional Engineer and complying with the performance requirements and design criteria indicated herein.
 - b. Submit the structural design for the metal stair and railing system, including analysis data signed and sealed by the Professional Engineer responsible for their preparation, to the Program/Project Manager for approval.
 - 2. NAAMM Stair Standard:
 - a. Unless more stringent requirements are indicated in the Contract Documents, design the metal stairs and railings in accordance with the minimum standards specified in NAAMM AMP 510 for the designated class of the stair.
 - 1) Preassembled Stairs: Commercial class.
 - 2) Ornamental Stairs: Architectural class.
 - 3) Industrial-Type Stairs: Industrial class.
 - 3. Product Data:
 - a. Submit Product Data for the materials and products proposed to perform the Work of this Section to the Program/Project Manager for approval, including the following:
 - 1) Concrete filled metal-pan stair treads.
 - 2) Nonslip aggregates and nonslip-aggregate finishes.
 - 3) Abrasive nosings.
 - 4) Paint products.
 - 5) Conduit.
 - 6) Light fixture.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings of the metal stair and railing system.



- 1) Include plans, elevations, sections, details, and attachments to other work.
- 2) Include setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry.
 - a) For anchors and bolts required for installation of the metal stairs, but required to be installed under other Sections, prepare anchor and bolt templates.
- 3) Include conduit routing and light fixtures types for lighting as shown on the Contract Documents.
- b. Submit the metal stair and railing system Shop Drawings and anchor and bolt templates to the Program/Project Manager for approval.

E. Materials:

1. Metal Surfaces:
 - a. Unless otherwise indicated in the Contract Documents, provide metal materials with smooth, flat surfaces.
 - b. For metal components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
2. Steel Plates, Shapes, and Bars:
 - a. Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
3. Cold-Rolled Steel Sheet:
 - a. Unless another grade is required by design loads for exposed applications, provide uncoated cold-rolled steel sheet at a minimum complying either with the requirements for Type B commercial steel (CS), or Grade 25 (Grade 170) structural steel (SS), specified in ASTM A 1008/A 1008M.
4. Hot-Rolled Steel Sheet:
 - a. Unless another grade is required by design loads, provide uncoated hot-rolled steel sheet at a minimum complying either with the requirements for Type B commercial steel (CS), or Grade 30 (Grade 205) structural steel, specified in ASTM A 1011/A 1011M.
5. Steel Tubing:
 - a. Provide cold formed steel tubing complying with the requirements specified in ASTM A 500.
 - b. Provide welded steel tubing complying with the requirements specified in ASTM A 513.
6. Fasteners:
 - a. Provide zinc-plated fasteners with a coating complying with the requirements specified in ASTM B 633 or ASTM F 1941 (ASTM F 1941M).
 - 1) For exterior fasteners, provide a Class Fe/Zn 12 coating.



- 2) For fasteners built into exterior walls, provide a Class Fe/Zn 5 coating.
 - b. Select fasteners of the type, grade, and class required.
7. Welding Rods and Bare Electrodes:
 - a. Furnish welding rods and bare electrodes selected in accordance with the requirements for the metal alloy being welded in the American Welding Society (AWS) references.
8. Heavy duty ADA grating:
 - a. Unless otherwise indicated in drawings, (or approved equal product) provide type 64-10-WH-60 1/8" Wheels n' Heels InVent Heavy Duty Grade 50 Carbon Steel Grating with OnGrip Spray Traction Surface and Galvanized finish.
 - b. Fabricated by assembling tubular steel cross bars through round holes in 1/8" thick rectangular top surface bars space 5/8" on center and 1/8" thick rectangular heavy duty cross bars space 3-3/4" on center that are then permanently locked in place by swaging.
 - c. Heavy duty main bars are 4" on center inserted beneath and perpendicular to the top surface then fillet at each main bearing bar / heavy cross bar intersection.
 - 1) Top surface bar Spacing: 5/8" on center.
 - 2) Top surface bar depth is 1" and thickness is 1/8" to provide 5/16" space between bars.
 - 3) Main Bearing Bars 1/4" thick spaced 4" on center and their depth is to be based on loading requirements and the clear span shown on the drawings. Main bearing bars are perpendicular to top surface bars.
 - 4) Heavy Duty Cross Bars 1-1/2" x 1/8" are flush with top surface and spaced 3-3/4" on center.
 - 5) All Top Surface Bars shall have OnGrip Spray Traction Surface.
9. Concrete Materials:
 - a. Unless otherwise indicated in the Contract Documents, provide concrete materials complying with the requirements for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20MPa) specified in Section 03300, Cast-In-Place Concrete.
10. Welded Wire Fabric:
 - a. Unless otherwise indicated in the Contract Documents, provide 6-inch by 6-inch (152mm by 152mm), W1.4 by W1.4, welded wire fabric complying with the requirements specified in ASTM A 185/A 185M.
11. Anchors:
 - a. Provide the manufacturer's standard anchors, either integral or applied to metal stair units, for embedding units in concrete.
12. Tread Warning Stripe:
 - a. Provide 2-inch wide, contrasting color tread warning stripe.
13. Integral Detectable Warning Stripe



- a. Provide nosings with integral detectable warning stripe to match tread style and color.
- b. Finish Color: As selected by Architect.
- 14. Conduit
 - a. Provide minimum 1" rigid conduit specified in Section 16130 – Raceways and Boxes.
- 15. Light Fixture
 - a. Provide LED light fixtures with color temperature of 4000K specified in Section 16521 – Exterior Lighting.

F. Shop Fabrication:

- 1. Stair Assemblies:
 - a. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor the stairs and platforms on the supporting structure.
 - 1) Unless otherwise indicated in the Contract Documents, join components together by welding.
 - 2) Provide connections that maintain the structural value of the joined pieces.
 - 3) For exterior stairs, fabricate the treads and platforms so the finished walking surfaces slope to drain the surfaces.
- 2. Preassembled Stairs:
 - a. Assemble preassembled stairs in the shop to the greatest extent possible.
 - b. Disassemble units only as necessary for shipping and to accommodate handling limitations.
- 3. Metal Fabrication:
 - a. Cut, drill, and punch metals cleanly and accurately.
 - 1) Remove burrs and ease edges.
 - 2) Remove sharp or rough areas on exposed surfaces.
 - b. Bent Metal Corners:
 - 1) Form bent-metal corners to the smallest radius possible without impairing the work.
 - c. Welded Connections:
 - 1) Fabricate welded connections in accordance with the following requirements:
 - a) Use materials and methods that minimize distortion and develop the strength and corrosion resistance of the base metals.
 - b) Obtain fusion without undercut or overlap.
 - c) Remove welding flux immediately.
 - d) Unless otherwise indicated in the Contract Documents, weld exposed corners and seams continuously.



- e) At exposed connections, finish exposed welds in accordance with the NOMMA Voluntary Joint Finish Standards for Type 1 welds (no evidence of a welded joint).
 - f) Grind welded joints smooth so no sharp or abrasive corners, edges, or surfaces remain.
 - d. Exposed Connections:
 - 1) Form exposed connections so they have flush and smooth hairline joints.
 - 2) Provide concealed fasteners wherever possible.
 - e. Joints:
 - 1) Locate exposed joints where they will be the least conspicuous.
 - 2) Fabricate joints that will be exposed to the weather so water will be excluded from the joint.
 - a) Provide weep holes where water may accumulate.
- 4. Steel-Framed Stair Fabrication:
 - a. Stair Framing:
 - 1) Fabricate stringers from steel channels.
 - a) Provide closures for exposed ends of channel stringers.
 - 2) Construct platforms from steel channel headers and miscellaneous framing members as needed to comply with performance requirements.
 - 3) Weld stringers to headers, and weld framing members to stringers and headers.
 - 4) If bolts are used for fastening the framing together, fabricate and join the stair framing so the bolts are not exposed on finished surfaces.
 - b. Metal-Pan Stairs:
 - 1) For metal-pan stairs, fabricate the risers, subtread pans, and subplatforms from steel sheet having the thickness needed to comply with performance requirements, but not less than 0.067 inch (1.7mm) thick; and formed to have the configurations shown on the Contract Documents.
 - a) Provide either stair assemblies with metal-pan subtreads filled during fabrication with reinforced concrete, or provide epoxy-resin-filled treads, reinforced with glass fibers and having a slip-resistant, abrasive surface.
 - 2) For metal-grating stairs, fabricate the risers, treads and nosings from steel sheet having the thickness needed to comply with performance requirements, but not less than 0.067 inch (1/7 mm) thick; and formed to have the configurations shown on the Contract Documents.
 - a) Provide tread as a prefabricated heavy duty ADA compliant steel bar grating with checkered plate angle nosing, and standard end plates.
- 5. Stair Railings:



- a. For pipe and tube railings not attached to the metal stairs or to the walls adjacent to the metal stairs, provide pipe and tube railings complying with the requirements specified in Section 05521, Pipe and Tube Railings.
- b. For railings attached to the metal stairs or to walls adjacent to metal stairs, fabricate the railing from steel tube in accordance with the design requirements, dimensions, details, finishes, and member sizes indicated in the Contract Documents, including the wall thicknesses of the tubes, post spacing, and anchorages, but not according to requirements less than those needed to withstand the loads indicated in the Contract Documents.
 - 1) Rails and Posts:
 - a) Provide 1-5/8-inch (41mm) diameter top and bottom rails, and 1-1/2-inch (38mm) square posts.
 - 2) Picket Infill:
 - a) Where picket infill is indicated in the Contract Documents, provide 1-1/2-inch (37mm) by 1/2-inch (13mm) flat pickets spaced to provide less than 4 inches (100mm) clear between pickets.
- c. Provide welded connections when fabricating railings.
 - 1) Cope components at connections to provide a close fit, or use fittings designed for this purpose.
 - 2) At connections, including at fittings, weld all around.
- d. Changes of Direction:
 - 1) Form changes in direction of railings by bending the rails, or by inserting prefabricated elbow fittings.
- e. Curves:
 - 1) Form curves by bending members in jigs that produce a uniform curvature without buckling the rails.
- f. Exposed Ends of Railing Members:
 - 1) Close the exposed ends of railing members by using prefabricated end fittings.
- g. Wall Returns:
 - 1) At the ends of wall-mounted handrails, provide wall returns.
- h. Brackets, Flanges, Fittings, and Anchors:
 - 1) Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting stair railings components; and for attaching stair railings to other work.
 - a) Connect stair railing posts to the stair framing by welding the posts directly to the stair framing.
 - b) For non-galvanized railings, provide non-galvanized ferrous metal fittings, brackets, fasteners, and sleeves; except provide galvanized anchors for the anchors to be embedded in exterior masonry and concrete construction.
- i. Fillers:



- 1) To transfer wall bracket loads through wall finishes, such as plaster or gypsum board, provide fillers made from steel plate or other suitably crush-resistant material.
- 2) Size the fillers to suit the wall finish thicknesses.

G. Finishes:

1. Primer Materials:

a. Shop Primers:

- 1) Provide shop primers complying with the requirements specified in Section 09912, Painting, and Section 09960, High-Performance Coatings.
- 2) Universal Shop Primer:
 - a) Provide fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with the requirements specified in MPI # 79, and compatible with the topcoat.

2. Shop Finishing Methods:

- a. Finish metal stairs after assembly.
- b. For finish designations and application recommendations, comply with the requirements specified in NAAMM/NOMMA AMP 500.
- c. Shop Priming:
 - 1) Prepare uncoated ferrous-metal surfaces for priming in accordance with the requirements specified in SSPC-SP 6/NACE No. 3.
 - 2) Apply shop primer to the uncoated surfaces of metal stair components in accordance with the requirements specified in SSPC-PA 1 for shop painting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Before proceeding to erect the metal stairs, verify the elevations of concrete and masonry bearing surfaces and the locations of anchorages are in compliance with the Contract Documents and ready to receive the work of this Section.
2. Verify that wall surfaces adjacent to handrail to be installed are smooth.

B. Evaluation and Assessment:

1. Immediately report any errors in the metal stairs which will prevent the proper installation and fitting of parts.
 - a. Report errors resulting from either shop fabrication or deformation resulting from handling or transportation.
2. Do not proceed with erection until unsatisfactory conditions have been corrected.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the metal stairs.
- B. Surface Preparation:
 - 1. If anchor rods or bolts or other embedded items were cast in the substructure when it was constructed, ensure they are held firmly in the correct position and at the proper elevation by suitable templates.
- C. Demolition / Removal:
 - 1. Perform the cutting, drilling, and fitting required for installing the metal stairs.

3.03 INSTALLATION

- A. Metal Stair Installation:
 - 1. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
 - 2. Set the metal stair units so they are free of rack.
 - 3. Set each metal stair unit in its proper location, and to the correct alignments and elevations measured accurately from established lines and levels.
 - 4. Unless otherwise indicated in the Contract Documents, install the metal stairs by welding the stair framing to the steel structure or to weld plates cast into the concrete.
 - a. For cast-metal units that are to be set into concrete, apply bituminous paint to their concealed surfaces.
 - b. For extruded units that are to be set into concrete, apply clear lacquer to their concealed surfaces.
 - 5. Fit exposed field connections accurately together to form hairline joints.
 - 6. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support the landings from the floor construction above or below.
 - a. Locate hanger rods and struts where they will not encroach on required stair widths, and will be within the fire-resistance-rated stair enclosure.
 - 7. Where masonry walls will support the metal stairs, before installing the masonry provide temporary supporting struts that are designed for facilitating erection of steel stair components.
- B. Concrete Fill:
 - 1. Place and finish concrete fill for treads and platforms in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete.



C. Installing Steel Tube Railings:

1. Before anchoring steel tube railing systems, adjust the railing at abutting joints to ensure the alignment matches.
2. Space posts at the spacing specified or indicated on the Contract Drawings; in no spacing is specified or indicated, space the posts as required to handle the design loads.
3. Anchor the steel tube posts to steel supporting members by directly welding the posts to the members.
4. To anchor handrail ends to concrete and masonry, weld round steel flanges to the rail ends, and post-install anchors and bolts in the concrete or masonry.

D. Special Techniques:

1. Field Welding:
 - a. Comply with requirements for welding specified in Subparagraph 2.01.F.3.c.
 - b. Weld the connections that are not to be left as exposed joints, but that could not be shop welded due to shipping size limitations.
 - c. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication, and are for bolted or screwed field connection.
2. Tread Warning Stripes:
 - a. On each exterior stair and top landing, apply a tread warning stripe 1 inch from the edge of the nosing of the stair or landing.
 - b. On each interior top and bottom landing, apply a tread warning stripe 1 inch from the edge of the nosing of the landings.
3. Conduit, Wire, and Light Fixture
 - a. Install conduit to light fixture locations as identified in the shop drawings.
 - b. Provide pull boxes in conduit runs that exceed 180 degrees.
 - c. Mount light fixtures in accordance with manufacturer instructions.

E. Interface with Other Work:

1. To attach handrails to walls, provide wall brackets having a 1-1/2 inch clearance from the inside face of the handrail to the finished wall surface.
 - a. Locate the brackets as specified or indicated on the Contract Drawings.
 - 1) If no location is specified or indicated, locate the brackets as required to handle the structural loads.
 - b. For anchorage to concrete and solid masonry, provide drilled-in expansion shields and hanger or lag bolts.
 - 1) For concealed bolt anchoring of handrails to walls, provide a bracket having a flange tapped for concealed threaded hanger bolts.
 - 2) For exposed bolt anchoring of handrails to walls, provide a bracket having predrilled holes for exposed bolts.



- c. For anchorage to hollow masonry, provide toggle bolts.
- d. For anchorage to gypsum board assemblies, provide self-tapping screws of a size and type necessary for attaching the brackets directly to the steel framing or concealed steel reinforcements and for supporting the structural loads.

3.04 REPAIR/RESTORATION

- A. Touchup Painting:
 - 1. Immediately after metal stairs are erected, clean the field welds, bolted connections, and abraded areas of shop paint; and paint the exposed areas using the same material used for the shop painting in accordance with the requirements specified in SSPC-PA 1 for touching up shop-painted surfaces.
- B. Repairing Galvanized Surfaces:
 - 1. Clean field welds, bolted connections, and abraded areas of galvanized metal stairs, and repair the galvanizing in accordance with the requirements specified in ASTM A 780.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when metal stairs are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Inspections:
 - a. Inspect the bolted and welded connections.
 - b. Confirm the metal stairs are square, plumb, and level.
 - c. Verify the welders and welding materials in the field are properly certified.
- B. Non-Conforming Work



1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.

3.06 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	12/23/2011	N/A	Edited 1.02.A.1., new 1.02.C.11., new 1.04.B., deleted 1.05.C., deleted 1.05.D, new 2.01.B.	Updated sustainability information.
2	03/30/2018	N/A	1.01.C, 2.01.C.1, 2.01.C.4	SGJJR/KHA Edits





SECTION 05520

HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for shop fabricated steel and aluminum handrails and railings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 05120 - Structural Steel.
 - 3. Section 09960 - High Performance Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Reference Standards:
 - 1. Aluminum Alloy Association, Inc.
 - a. Aluminum Standards and Data.
 - 2. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
 - c. AWS Specifications for Welded Highway and Railway Bridges.
 - 3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.



- b. ASTM A 53/A 53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- c. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- d. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- e. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- f. ASTM B 241/B 241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. Phoenix Supplemental Standard Details for Public Works - Construction:
 - 1) Detail No. P1173 Handrail Detail.
- 5. Society for Protective Coatings (SSPC):
 - a. SSPC-SP 1 – Solvent Cleaning.
 - b. SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
 - c. SSPC-Paint 29 – Zinc Dust Sacrificial Primer, Performance-Based.
 - d. SSPC-PA 1 – Shop, Field and Maintenance Painting.
- 6. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 7. Institute for Sustainability Infrastructure (ISI):
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate the installation of handrails with installation of the adjacent construction.
- B. Scheduling
 - 1. Coordinate the handrail fabrication schedule with construction progress to avoid delaying the Work.

1.04 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Railing and handrail systems.
 - b. Samples
 - 1) Samples as may be requested by the Program/Project Manager.
 - c. Certificates:
 - 1) Mill reports for steel and aluminum materials.
 - d. Qualifications:
 - 1) Welding procedure qualification test records.
 - 2) Welding Certificates.
 - 3) Fabricator Qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied primer.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Qualifications:

1. Fabricator Qualifications:
 - a. Employ a firm experienced in producing metal handrails similar to that indicated for this Contract, and with a record of successful in-service performance, as well as sufficient production capacity to make required units.
 - 1) Submit Fabricator qualifications to demonstrate the capabilities and experience of the Fabricator, including a list of completed projects with project name, addresses, names of designers and



- owners, and other information applicable to the Program/Project Manager for approval.
2. Welding Qualifications:
 - a. Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.
 - 1) For all procedures, other than those set forth in AWS D1.1/D1.1M and AWS D1.2/D1.2M, submit a copy of the welding procedure qualification test records.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M and AWS D1.2/D1.2M, for the procedures.
 - 1) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- C. Certifications:
1. Submit certified copies of mill certificates certifying compliance with the requirements specified in this Section to the Program/Project Manager for approval.
 - a. Mill certificates are not required for miscellaneous hardware, nuts, bolts, washers, and similar items.
- D. Site Samples:
1. Submit Samples of the materials and finished products as may be requested by the Program/Project Manager to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
1. Deliver materials to the Site on the day(s) of installation.
 2. Do not store materials at the Site.
 3. Package and protect materials to limit field repairs.



PART 2 PRODUCTS

2.01 HANDRAILS AND RAILINGS

A. Sustainability Requirements:

1. Recycled Content
 - a. Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.

B. Design Criteria:

1. Provide handrails and railings designed in accordance with Detail No. P1173 in the Phoenix Supplemental Standard Details for Public Works – Construction.
2. For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes.
3. Do not use materials with exposed pitting, scam marks, roller marks, rotted trade names, or roughness.
4. For structures on curves, either horizontal or vertical, provide railing conforming closely to the curvature of the structure.
5. Evenly space vertical posts.
6. Shop Drawings:
 - a. Submit Shop Drawings of railing and handrail systems showing fabrication and installation details for the proposed metal fabrications to the Program/Project Manager for approval.
 - 1) Include plans, elevations, sections, and details of handrails and their connections
 - 2) Show anchorage and accessory items.
 - 3) Submit setting drawings, diagrams, templates, instructions, and directions for installing anchorages.

C. Materials:

1. Ferrous Metals:
 - a. Steel Plates, Shapes, and Bars:
 - 1) Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - b. Steel Tubing:



- 1) Provide cold-formed steel tubing complying with the requirements specified in ASTM A 500.
 - c. Steel Pipe:
 - 1) Provide standard weight (schedule 40) steel pipe complying with the requirements specified in ASTM A 53/A 53M.
2. Non-Ferrous Metals:
 - a. Aluminum Seamless Pipe:
 - 1) Provide Alloy 6063-T6 aluminum pipe or seamless tube complying with the requirements specified in ASTM B 241/B 241M.
 - 2) Provide materials complying with the aluminum standards and data published by the Aluminum Alloy Association, Inc.
3. Fasteners:
 - a. Select fasteners of the type, grade, and class required.
 - b. Unless otherwise indicated in the Contract Documents, provide the following types of fasteners:
 - 1) For exterior applications, provide Type 304 stainless steel bolts and fasteners.
 - 2) For fastening aluminum, provide stainless steel fasteners.
 - c. Expansion Anchors:
 - 1) Provide expansion anchor bolt and sleeve assemblies as specified in Section 05120, Structural Steel, and indicated on the Contract Drawings.
- D. Shop Fabrication:
 1. Fabricate railings and handrails from welded or seamless members of the size and thickness shown on the Contract Drawings.
 2. Provide railing panels that are straight and true to the dimensions indicated.
 3. Galvanize railings and handrails in accordance with the requirements specified in ASTM A 123/A 123M.
 4. Shear and punch metals cleanly and accurately, and remove burrs.
 5. Remove sharp or rough areas on exposed surfaces.
 6. Weld corners and seams continuously, and comply with the following requirements:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of the base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and the contour of the welded surface matches those adjacent.
 7. Provide an anchorage of the type indicated in the Contract Documents.



- a. Coordinate the anchorage with the supporting structure.
- b. Fabricate and space anchoring devices to secure the metal fabrication rigidly in place, and to support the indicated loads.
8. Fabricate joints that will be exposed to the weather so water is excluded, or provide weep holes where water may accumulate.

E. Finishes:

1. Primer Materials:

a. Zinc-Rich Primer:

- 1) Provide zinc-rich primer complying with the requirements specified in SSPC-Paint 20 or SSPC-Paint 29, and compatible with the topcoat.
- 2) Provide primer having a volatile organic compound (VOC) content of 3.5 pounds per gallon or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

3) Manufacturers:

- a) International Protective Coatings, Interzinc® 315 Epoxy Zinc-Rich Primer, <http://www.international-pc.com/>.
- b) Sherwin-Williams Company, Corothane I GalvaPac Zinc Primer, www.sherwin-williams.com.
- c) Tnemec Company, Inc., Tneme-Zinc 90-97, www.tnemec.com.
- d) Approved equal.

2. Finish Materials:

a. Galvanizing Repair Paint:

- 1) For re-galvanizing welds in steel, provide high-zinc-dust-content paint complying with the requirements specified in SSPC-Paint 20.
- 2) Apply 2 coats.

3. Shop Finishing Methods:

a. Galvanized Surfaces:

- 1) Clean surfaces to be galvanized following the solvent cleaning procedures specified in SSPC-SP 1.
- 2) Galvanize railings and handrails in accordance to the requirements specified in ASTM A 53/A 53M after fabrication.
- 3) Provide a minimum weight of coating of 1.80 ounces per square foot.
- 4) Provide a finished product free from blisters and excess spelter, and provide an even, smooth, and uniform coating.
- 5) Uncoated spots or damaged coatings due to poor workmanship, rough handling or other reason are cause for rejection.
- 6) Wire test coupons for determining the quality of galvanizing to the materials to be galvanized before immersion so the amount of



coating deposited on the materials will be represented on the test coupons.

- b. Painted Surfaces:
 - 1) Prime surfaces.
 - 2) Paint the railings and handrails in accordance with the requirements specified in Section 09960, High Performance Coatings.
 - 3) Provide the color indicated in the Contract Drawings.

2.02 ACCESSORIES

- A. Furnish all required fittings, anchoring hardware, and miscellaneous accessories as required to provide a complete system, fabricated, painted and installed in accordance with the Contract Drawings and this Section.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify adjacent construction is complete and ready for installation of handrails prior to delivery of materials to Site.
 - 2. Field Measurement:
 - a. Verify dimensions of other construction by field measurements before fabrication of handrails and railings, and indicate the measurements on Shop Drawings.

3.02 PREPARATION

- A. Surface Preparation
 - 1. Provide anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.
 - a. Set sleeves in concrete with their tops flush with the finish surface elevations.
 - 1) Prevent water and concrete from entering the sleeves.

3.03 INSTALLATION

- A. Accurately set the handrails in the proper location, in the proper alignment, and at the proper elevation when measured from established lines and levels, with the edges and surfaces level, plumb, true, and free of rack.
 - 1. Install posts and balusters vertical and parallel.



B. Tolerances:

1. Deviation from the vertical for the full height of the panel is not to exceed 5/8-inch.

3.04 REPAIR

A. Touchup Painting:

1. Clean field welds, bolted connections, and abraded areas of shop paint; and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
2. Apply paint by either brush or spray to provide a 2.0 mil (0.05mm) minimum dry film thickness.

B. Galvanized Surfaces:

1. Clean field welds, bolted connections, and abraded areas, and repair galvanizing in accordance with the requirements specified in ASTM A 780.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition





SECTION 05521

PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for steel pipe and tube railings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 05511 - Metal Stairs.
 - 5. Section 09260 - Gypsum Board Assemblies.
 - 6. Section 09912 – Painting.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - b. AWS D1.6 - Structural Welding Code–Stainless Steel.
 - 2. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.



- e. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
- f. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- g. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- h. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- i. ASTM D 1187 – Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
- j. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 6. Society for Protective Coatings (SSPC):
 - a. SSPC–PA 1 – Shop, Field and Maintenance Painting.
- 7. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of the anchorages for the pipe and tube railings with the Work of other Sections.
- B. Sequencing:
 - 1. Deliver setting drawings, templates, and directions for installing anchorages for the pipe and tube railings, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry to the Site in time so the installation of the anchorages will not delay the Work.
 - 2. Sequence the installation of the pipe and tube railings so wall attachments are made only to completed walls.
 - a. Do not support railings temporarily by any means that do not satisfy the structural performance requirements.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Anchoring cement.
 - 2) Anchors.
 - 3) Fasteners.
 - 4) Grout.
 - 5) Paint products.
 - b. Shop Drawings:
 - 1) Pipe and tube railing system.
 - c. Samples:
 - 1) Samples for initial selection.
 - 2) Verification Samples for sections of each distinctly different linear railing member.
 - 3) Verification Samples for fittings and brackets.
 - 4) Mock-up of an assembled railing system.
 - d. Certificates:
 - 1) Mill certificates for stainless steel products.
 - e. Delegated Design Submittals:
 - 1) Structural analysis data for the pipe and tube railing system.
 - f. Qualification Statements:
 - 1) Professional Engineer qualifications.
 - 2) Welding procedure specifications (WPS) test records.
 - 3) Welding Certificates.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - c. Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied primer.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered Special Inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Professional Engineer Qualifications:
 - a. Have the pipe and tube railing manufacturer employ a licensed Professional Engineer, registered in the State of Arizona, who has experience performing design calculations for standard pipe and tube railing units and preparing Shop Drawings.
 - 1) Submit the Professional Engineer's qualifications to the Program/Program Manager for approval.
 - 2. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.6, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welder Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M and AWS D1.6, for the procedures to be used.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.



- a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- C. Certifications:
 - 1. Mill Certificates:
 - a. Submit mill certificates for stainless steel products, signed by the manufacturers and certifying that the stainless steel products furnished comply with the requirements specified, to the Program/Project Manager for approval.
- D. Site Samples:
 - 1. Samples for Initial Selection:
 - a. For products involving selection of color, texture, or design, including mechanical finishes on stainless steel, submit Samples to the Program/Project Manager for approval of the initial selections.
 - 2. Verification Samples:
 - a. For each type of exposed finish required, submit verification Samples to the Program/Project Manager for approval, including the following:
 - 1) Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2) Fittings and brackets.
- E. Mock-Ups:
 - 1. For each type of exposed finish required, submit a mock-up of an assembled railing system, made from full-size components, including the top rail, post, handrail, and infill, to the Program/Project Manager for approval.
 - a. The mock-up need not be full height.
 - b. Show the method of finishing and connecting members at intersections.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Storage and Handling Requirements:



1. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Pisor Industries, Inc.
 - b. Sharpe Products, <http://sharpeproducts.com/favicon.ico>.
 - c. Wagner, R & B, Inc.; a division of the Wagner Companies, www.wagnercompanies.com.
 - d. Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain each type of railing through one source from a single manufacturer.
- B. ENVISION Requirements:
 1. Recycled Content
 - a. Provide Structural Steel whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
 2. Low Emitting Materials – Paints and Coatings
 - a. When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.
- C. Performance:
 1. Anchors:



- a. Provide anchors with the capability to sustain the following loads, as determined by a qualified independent Testing and Inspection Agency in accordance with the testing methods specified in ASTM E 488, without failure:
 - 1) When installed in unit masonry, a load equal to 6 times the load imposed.
 - 2) When installed in concrete, a load equal to 4 times the load imposed.
- D. Design Criteria:
 - 1. For steel tube railings associated with metal stairs, provide railings complying with the requirements specified in Section 05511, Metal Stairs.
 - 2. Connections:
 - a. Design connections to maintain the structural value of joined pieces.
 - b. Design connections that will be exposed to weather to exclude water, and to include weep holes where water may accumulate.
 - 3. Close exposed ends of railing members with prefabricated end fittings.
 - 4. Wall Returns:
 - a. Unless otherwise indicated, provide wall returns at the ends of wall-mounted handrails.
 - 1) Close the ends of returns unless the clearance between the end of the rail and the wall is 1/4 inch or less.
 - 5. Thermal Movements:
 - a. Prevent buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects in exterior railings, by providing railings designed to allow thermal movement resulting from the following maximum change (range) in ambient and surface temperatures.
 - 1) Ambient Temperature Change (Range): 120 degrees Fahrenheit,
 - 2) Material Surfaces Temperature Change (Range): 180 degrees Fahrenheit.
 - b. Base engineering calculations on the surface temperatures of the materials due to both solar heat gain and nighttime-sky heat loss.
 - 6. Control of Corrosion:
 - a. Prevent galvanic action and other forms of corrosion in railings by insulating metals and other materials from direct contact with incompatible materials.
 - 7. Product Data:
 - a. Submit Product Data for the materials and products proposed to perform the Work of this Section to the Program/Project Manager for approval, including the following:
 - 1) Anchoring cement.



- 2) Anchors.
- 3) Fasteners.
- 4) Grout.
- 5) Paint products.
8. Shop Drawings:
 - a. Prepare Shop Drawings of the pipe and tube railing system.
 - 1) Include plans, elevations, sections, details, and attachments to other work.
 - 2) Include setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry.
 - b. Submit the pipe and tube railing system Shop Drawings to the Program/Project Manager for approval.
9. Design Calculations:
 - a. For pipe and tube railing system products required to comply with the specified design loads, prepare structural analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
 - b. Submit the structural analysis data for the pipe and tube railing system to the Program/Project Manager for approval.

E. Materials:

1. Railing Components:
 - a. Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
 - b. Plates, Shapes, and Bars:
 - 1) Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - c. Tubing:
 - 1) Provide either cold formed steel tubing complying with the requirements specified in ASTM A 500, or Type 5 mandrel drawn steel tubing complying with the requirements specified in ASTM A 513.
 - d. Brackets, Flanges, and Anchors:
 - 1) Unless otherwise indicated, provide cast or formed metal brackets, flanges, and anchors fabricated from same material and having the same finish as the rails being supported.
 - 2) Provide wall brackets providing a 1-1/2-inch clearance from the inside face of the handrail to the finished wall surface, and having predrilled holes for exposed bolt anchorage.
2. Welding Rods and Bare Electrodes:



- a. Provide welding rods and bare electrodes selected in accordance with the requirements specified in the AWS specifications for the metal alloy being welded.
- 3. Fasteners:
 - a. Fasteners for Steel Railings:
 - 1) Provide steel fasteners plated in accordance with the requirements specified for Class Fe/Zn 25 electrodeposited zinc coating in ASTM B 633.
 - b. Fasteners for Anchoring Railings to Other Construction:
 - 1) Provide a type, grade, and class of fastener selected to produce connections suitable for anchoring the railings to the other types of construction indicated in the Contract Documents, and capable of withstanding the design loads specified.
 - c. Fasteners for Interconnecting Railing Components:
 - 1) Provide concealed fasteners for interconnecting railing components, and for attaching the railing components to other work, unless exposed fasteners are unavoidable or are the standard fastening method for the railings indicated in the approved Shop Drawings.
 - 2) For exposed fasteners, provide square or hex socket flat-head machine screws unless otherwise indicated.
- 4. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- 5. For non-galvanized steel railings, provide non-galvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize the anchors to be embedded in exterior concrete or masonry.

F. Fabrication:

- 1. Shop Fabrication:
 - a. Fabricate railings of the design, dimensions, member sizes and spacing, details, finish, and anchorage indicated in the Contract Documents, but not less than those required for supporting the structural loads.
 - 1) Provide weep holes where water may accumulate.
 - b. Metal Fabrication:
 - 1) Form the railing work true to line and level, with accurate angles and surfaces.
 - a) Form changes in direction as detailed.
 - b) Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required.



- (1) Maintain the cross section of each member throughout the entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of the components.
- 2) Cut, drill, and punch metals cleanly and accurately.
 - a) Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated.
 - b) Remove sharp or rough areas on exposed surfaces.
- 3) Welded Connections:
 - a) Unless otherwise indicated, fabricate railings with welded connections in accordance with the following requirements:
 - (1) Use materials and methods that minimize distortion and develop the strength and corrosion resistance of the base metals.
 - (2) Obtain fusion without undercut or overlap.
 - (3) Remove welding flux immediately.
 - (4) At connections, cope the components to provide a close fit, or provide fittings designed for this purpose.
 - (5) At connections, including at fittings, weld all around.
- 4) Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- 5) At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing, and the welded surfaces match the contours of adjoining surfaces.
- 6) Grind welded joints and surfaces smooth so no sharp or abrasive corners, edges, or surfaces survive.
- 7) Unless the vent and drain holes that will be exposed in the finished Work are indicated to remain as weep holes, plug the holes with zinc solder, and file the solder off to create a smooth surface.

G. Assembly:

1. Factory Assembly

- a. Assemble railings in the shop to the greatest extent possible to minimize field splicing and assembly.
- b. Disassemble units only as necessary for shipping and handling limitations.
- c. Clearly mark units for reassembly and coordinated installation.

H. Finishes:

1. Primer Materials:

- a. For primer materials applied to pipe and tube railings, provide primer complying with the requirements specified in Section 09912, Painting.



2. Finish Materials:
 - a. Galvanizing:
 - 1) For hot-dip galvanized railings, provide galvanizing complying with the requirements specified in ASTM A 123/A 123M.
 - 2) For hot-dip galvanized hardware, provide galvanizing complying with the requirements specified in ASTM A 153/A 153M.
 - b. For paint finishes applied to pipe and tube railings, provide paint complying with the requirements specified in Section 09912, Painting.
3. Shop Finishing Methods:
 - a. For finish designations and application recommendations, comply with the requirements specified in NAAMM/NOMMA AMP 500.
 - b. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - c. Unless otherwise indicated, apply shop primer and shop paint to the uncoated surfaces of the railing components, except those with galvanized finishes and those to be embedded in concrete or masonry, in accordance with the requirements specified in SSPC-PA 1 for shop painting.
 - 1) Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2) Provide exposed fasteners with a finish matching the appearance, including the color and texture, of the railings.

2.02 ACCESSORIES

- A. Anchoring Cement:
 1. Provide a factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at the Site to create a pourable anchoring, patching, and grouting compound.
 2. For exterior locations and where indicated, provide a formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended by the manufacturer for exterior use.
- B. Anchors:
 1. Provide cast-in-place, chemical, or torque-controlled expansion anchors, fabricated from corrosion-resistant materials.
- C. Backing for Anchoring Railings:
 1. For anchoring railings, provide metal backing complying with the requirements specified in Section 09260, Gypsum Board Assemblies.
- D. Bituminous Paint:



1. Provide a cold-applied asphalt emulsion complying with the requirements specified in ASTM D 1187.

E. Nonshrink, Nonmetallic Grout:

1. Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify the actual locations of walls and other construction contiguous with the railings by taking field measurements before fabricating the railings, and indicate these measurements on Shop Drawings.
2. Examine gypsum board assemblies, where they have been reinforced to receive anchors, to verify that the locations of concealed reinforcements have been clearly marked for the railing installer.
 - a. Locate the reinforcements, and mark their locations if this has not already been done.
3. Ensure that wall surfaces adjacent to the handrail are smooth.

B. Evaluation and Assessment:

1. Immediately report any errors in the pipe and tube railings which will prevent the proper installation and fitting of parts.
 - a. Report errors resulting from either shop fabrication or deformation resulting from handling or transportation.
2. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the pipe and tube railings.

B. Surface Preparation:

1. If anchor rods or bolts or other embedded items were cast in the substructure when it was constructed, ensure they are held firmly in the correct position and at the proper elevation by suitable templates.

C. Demolition / Removal:



1. Perform the cutting, drilling, and fitting required for installing the pipe and tube railings.

3.03 INSTALLATION

A. Pipe and Tube Railing Installation:

1. Set pipe and tube railings accurately in location, alignment, and elevation
 - a. Measure the railings from established lines and levels.
 - b. Set the railings free of rack.
2. Fit exposed field connections accurately together to form tight, hairline joints.
3. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication, and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - a. Perform cutting, drilling, and fitting required for installing the railings.
4. Before anchoring pipe and tube railing systems, adjust the railing at abutting joints to ensure the alignment matches.

B. Railing Connections:

1. Welded Connections:
 - a. For permanently connecting railing components, provide fully welded joints.
 - b. For field welding, comply with the requirements specified for shop welded connections in Subparagraph 2.01.F.1.b.3.
2. Expansion Joints:
 - a. Install expansion joints at the locations indicated in the Contract Drawings, but not farther apart than required to accommodate thermal movement.
 - 1) Locate the joints within 6 inches of a post.
 - b. Provide an internal slip-joint sleeve extending 2 inches beyond the joint on either side, and fastened securely to one side.

C. Anchoring Posts:

1. For posts to be installed in concrete, either form or core-drill holes not less than 5 inches deep and 3/4 inch larger than the outside diameter of the posts.
2. Clean loose material out of the holes, insert the posts in the holes, and fill the annular space between the post and the concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with the anchoring material manufacturer's written instructions.
3. Cover the anchorage joints with flanges made from the same metal as the posts, welded to the posts after the anchoring material has been placed.



D. Anchoring Railing Ends:

1. Anchor railing ends to concrete and masonry using round flanges connected to the railing ends, and anchored to the wall construction with anchors and bolts.

E. Attaching Handrails to Walls:

1. Provide wall brackets to attach handrails to walls.
2. Locate wall brackets as indicated in the Contract Documents; or, if not indicated, at the spacing required to support structural loads.
3. Secure the wall brackets to the building construction as follows:
 - a. For concrete and solid masonry anchorage, provide drilled-in expansion shields and hanger or lag bolts.
 - b. For hollow masonry anchorage, provide toggle bolts.
 - c. For steel-framed gypsum board partitions, fasten the brackets with toggle bolts installed through the flanges of the steel framing or through concealed steel reinforcements.

F. Interface with Other Work:

1. Provide anchorage devices and fasteners where necessary for securing railings, and for properly transferring loads, to in-place construction.
 - a. To interconnect railing members to other work, provide wall brackets, flanges, miscellaneous fittings, and anchors unless otherwise indicated.
 - b. At railing brackets and fittings fastened to plaster or gypsum board partitions, prevent rotation of the brackets and fittings or crushing of the substrate by providing fillers made from crush-resistant material, or use other means, to transfer the wall loads to the structural supports through the wall finishes.
 - c. For connecting railings to concrete or masonry work, provide inserts and other anchorage devices.
 - 1) Fabricate anchorage devices capable of withstanding the loads imposed by the railings.
 - 2) Coordinate the anchorage devices with the supporting structure.

G. Tolerances:

1. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
2. Align rails so variations from level for horizontal members, and variations from parallel with the rake of steps and ramps for sloping members, do not exceed 1/4 inch in 12 feet.



3.04 REPAIR/RESTORATION

- A. Restore finishes damaged during the installation and construction period so no evidence remains of correction work.
 - 1. Return items that cannot be refinished in the field to the shop.
 - 2. Make required alterations and refinish the entire unit, or provide new units.
- B. Touchup Painting:
 - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09912, Painting.
- C. Galvanized Surfaces:
 - 1. Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with the requirements specified in ASTM A 780.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Inspections:
 - a. Inspect the bolted and welded connections.
 - b. Confirm the pipe and tube railings are square, plumb, and level.
 - c. Verify that the welders and welding materials in the field are properly certified.
- B. Non-Conforming Work
 - 1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.

3.06 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect the finishes of pipe and tube railings from damage during the construction period by furnishing temporary protective coverings approved by the railing manufacturer.
 - 1. Remove the protective coverings at the time of Substantial Completion.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 05522

TEMPERED GLASS RAILING ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for a factory-fabricated structural glass balustrade system glazed with tempered glass.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01316 - Project Meetings.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Reference Standards:
 - 1. American National Standards Association (ANSI):
 - a. ANSI Z97.1 – Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.
 - 2. ASTM International (ASTM):
 - a. ASTM E 488 – Standard Test Methods for Strength of Anchors in Concrete and masonry Elements.
 - 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 5. United States Government:
 - a. Consumer Product Safety Commission (CPSC):
 - 1) 16 CFR 1201 – Safety Standard for Architectural Glazing Materials.
 - 6. Institute for Sustainability Infrastructure (ISI):
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Furnish the tempered glass railing components that are to be installed in other Work to the installer of that other Work, including blocking, sleeves, inserts, anchor bolts, embedded plates, and supports for attachment of the anchors for the tempered glass railing assemblies.



B. Pre-Installation Meetings:

1. One week prior to the start of the tempered glass railing system installation, convene a meeting at the Site in accordance with the requirements specified in Section 01316, Project Meetings, to review the installation of tempered glass railing components that are to be installed in other Work and areas of potential interference and conflicts with the installers of other Work.
 - a. Attendees at the pre-installation meeting must include, but are not limited to, the following:
 - 1) Contractor.
 - 2) Tempered glass railing manufacturer's representative.
 - 3) Program/Project Manager.
 - 4) Subcontractors performing adjacent work.
 - b. Coordinate the diagrams, templates, instructions, and directions for installation of anchorages and fasteners.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Tempered glass railing assemblies.
 - b. Shop Drawings:
 - 1) Tempered glass railing assemblies.
 - c. Qualification Statements:
 - 1) Tempered glass railing installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Test and evaluation reports for the tempered glass railing system.
 - b. Manufacturer's Instructions:
 - 1) Tempered glass railing manufacturer's written installation instructions and drawings.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or



volume) of materials used are from reclaimed or recycled materials.

2) Adhesives and Sealants

- a) Submit product data highlighting the VOC content for any field applied sealant used.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Tempered Glass Railing Assemblies Warranty.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Tempered Glass Railing Installer's Qualifications:
 - a. Employ mechanics experienced in the erection of architectural metal and glass to install the tempered glass railing.
 - b. Submit the tempered glass railing installer's qualifications to the Program/Project Manager for approval.

B. Preconstruction Testing:

1. Test and Evaluation Reports:
 - a. Submit test and evaluation reports for the tempered glass railing system, prepared by an independent testing laboratory and that show the tempered glass railing complies with the specified design and performance requirements, to the Program/Project Manager for information.
 - 1) If test and evaluation reports for the tempered glass railing system prepared by an independent testing laboratory are unavailable, have an approved independent testing laboratory perform physical tests on the tempered glass railing system and prepare test and evaluation reports to show the tempered glass railing complies with the specified design and performance requirements.
 - a) Submit the test and evaluation reports prepared by the independent testing laboratory for the tempered glass railing system to the Program/Project Manager for information.

C. Mock-Ups:

1. Provide a railing/glass system mock-up in accordance with the requirements specified in Section 01454, Mock-Up Requirements; and constructed of the same railing/glass type specified to demonstrate the aesthetic effects and set the quality standards for fabrication and installation.
2. Locate the mock-up where directed by the Program/Project Manager.
 - a. The approved mock-up may remain as part of the Work.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver the tempered glass railing assemblies in factory-provided protective coverings and packaging.
 - 2. Protect railing and glass materials against damage during transit, delivery, storage, and installation at the Site.
 - 3. Inspect the railing and glass materials upon their delivery to the Site for damage.
- B. Storage and Handling Requirements:
 - 1. Store the tempered glass railing materials and components prior to installation under cover in a dry location.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not install rail/glass systems until the area is enclosed, and the ambient temperature of the space is at least 65 degrees Fahrenheit and not more than 95 degrees Fahrenheit.
 - 2. For 24 hours before, during, and 24 hours after installation of the tempered glass railing system, maintain the ambient temperature of the space at not less than 65 degrees Fahrenheit, and not more than 95 degrees Fahrenheit.

1.08 WARRANTY

- A. Manufacturer Warranty:
 - 1. Tempered Glass Railing Assemblies Warranty:
 - a. Warrant the tempered glass railing assemblies against defects in materials, fabrication, finishes, and installation within the 1-year period after the Date of Substantial Completion:
 - 1) Submit a Tempered Glass Railing Assemblies Warranty on the tempered glass railing assemblies' manufacturer's standard or customized form, without monetary limitation, in which the tempered glass railing assembly manufacturer agrees to repair or replace tempered glass railing assemblies that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 TEMPERED GLASS RAILING ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - b. Manufacturers:
 - 1) Blumcraft of Pittsburgh; www.blumcraft.com
 - 2) Approved equal.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain tempered glass railing assemblies from a single source from a single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments and the ICC International Building Code (IBC) as Amended by the City of Phoenix.
- C. Sustainability Requirements:
 - 1. Recycled Content
 - a. Provide Stainless Steel Framing whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.
 - b. Provide Aluminum Framing whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 33 percent.
 - 2. Low Emitting Materials – Adhesives and Sealants
 - a. Provide silicon sealant with a VOC content of 250g/L or less.
- D. Design Criteria:
 - 1. Structural Requirements:
 - a. Provide tempered glass railing assemblies designed to withstand the structural loads specified in Table 05522-1.



Table 05522-1 Structural Load for Rail Heights of 3'-6" and Less			
Distributed Load (Pounds per Linear Foot)	Concentrated Load (Pounds)	Glass Thickness (Inches)	Minimum Length of Rail (Inches)
50	200	1/2	48
100	300	3/4	30

1. Mounting Assembly:
 - a. Provide a two-piece aluminum mounting system design that requires one "base member" to be permanently installed to the building structure, and prepared to receive the other "insert member" that has been securely bonded to the glass.
2. Handrails:
 - a. Provide aluminum handrails bonded to the top of the glass railing.
3. Filler Strips/Covers:
 - a. Provide filler strips/covers appropriate for the type of rail/glass and the glass thickness.
 - 1) Provide appropriate end caps where required to finish off the ends of the mounting members.
4. Product Data:
 - a. Obtain the manufacturer's Product Data for the tempered glass railing assemblies, including descriptions of materials, components, finishes, fabrication details, glass, anchors, and accessories.
 - 1) Include the manufacturer's installation instructions and instructions for care and cleaning of the tempered glass railing.
 - b. Submit the Product Data for the tempered glass railing assemblies to the Program/Project Manager for approval.
5. Shop Drawings:
 - a. Prepare Shop Drawings for the tempered glass railing assemblies.
 - 1) Indicate the sizes, layout, thicknesses, and loading conditions for the glass.
 - 2) Indicate the railing system elevations and sections, details of the profile, connection attachments, anchorage, size and type of fasteners and accessories, joint locations, brazed connections, transitions, terminations, and installation drawings.
 - b. Submit the Shop Drawings for the tempered glass railing assemblies to the Program/Project Manager for approval.

E. Materials:

1. Glass:

- a. Provide fully tempered glass complying with the requirements for safety glazing materials specified in ANSI Z97.1 and with the requirements for glass Categories 1 and 2 specified in 16 CFR 1201.



- b. Provide 1/2 inch or 3/4 inch thick glass as required to meet the structural loads specified in Table 05522-1.
 - c. Provide glass panels that can be removed for replacement at the building Site without chipping out the glass.
- 2. Stainless Steel:
 - a. Provide stainless steel having a Number 4 satin finish.

2.02 ACCESSORIES

- A. Anchors:
 - 1. For attachment of the tempered glass railing system to concrete, provide anchors capable of sustaining without failure a load equal to 4 times the load imposed when tested in accordance with the methods specified in ASTM E 488.
 - 2. Provide 1/2-inch by 4-inch concrete anchors.
- B. Cap Screws:
 - 1. For drilled and tapped or drilled and bolted attachment of the tempered glass railing system to steel, provide 1/2-inch, stainless steel, socket head cap screws.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the substrate and Site conditions are acceptable and ready to receive the tempered glass railing assemblies.
 - 2. Verify the field dimensions of the locations and areas to receive the tempered glass railing assemblies before fabricating the assemblies.
- B. Evaluation and Assessment:
 - 1. Notify Program/Project Engineer immediately of conditions that would prevent satisfactory installation.
 - 2. Do not proceed with work until detrimental conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the tempered glass railing assemblies.
- B. Surface Preparation:
 - 1. Clean surfaces to receive the tempered glass railing assemblies.
 - 2. For tempered glass railing installations in concrete, space anchor holes 12 inches apart center-to-center.



3. For drilled and tapped or drilled and bolted attachment of tempered glass railings to steel, space holes 24 inches apart center-to-center.

C. Demolition/Removal:

1. Remove materials and substances detrimental to the installation.

3.03 INSTALLATION

A. Review the tempered glass railing installation drawings before beginning installation of the tempered glass railing assemblies.

1. Comply with tempered glass railing manufacturer's installation instructions and drawings.
 - a. Submit the tempered glass railing manufacturer's written installation instructions and drawings to the Program/Project Manager for information.

B. Mounting Base Assembly:

1. Rigidly anchor the mounting base to the floor or stairs using sufficient reinforcement and anchoring as required and approved by the Program/Project Manager.
2. Draw the mounting screws and fittings up tightly.

C. Isolate dissimilar materials with a bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

D. Set the rails plumb and aligned.

E. Tolerances:

1. Install the tempered glass railing assemblies in compliance with the following installation tolerances:
 - a. Maximum Variation from Plumb: 1/4 inch per floor level, non-cumulative.
 - b. Maximum Offset from True Alignment: 1/4 inch.
 - c. Maximum Out-of-Position: 1/4 inch.

3.04 REPAIR/RESTORATION

A. Repair damage to exposed finishes so the repaired finishes are indistinguishable from undamaged areas.

1. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace the damaged items with new undamaged replacements.

3.05 SITE QUALITY CONTROL

A. Manufacturer Services:



1. Engage the services of the manufacturer to furnish field observation of the tempered glass railing installation.

3.06 CLEANING

- A. Remove protective film from exposed surfaces.
- B. Metal:
 1. Clean exposed metal finishes with potable water and a mild detergent in accordance with manufacturer recommendations.
 2. Do not use abrasive materials, chemicals, detergents, or other substances that may damage the material or finish to clean the exposed metal finishes.
- C. Glass and Glazing:
 1. Clean the glazing surfaces.
 2. Remove excess glazing sealant compounds, dirt, and other substances.
- D. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect installed components and finishes from damage after installation.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 05530

GRATINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for metal bar gratings and anchors.
 - 2. Requirements for metal frames and supports for gratings.
 - 3. Requirements for glass-fiber-reinforced plastic gratings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 05500 - Metal Fabrications.
 - 5. Section 05511 – Metal Stairs.
 - 6. Section 05521 – Pipe and Tube Railings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADA: Americans with Disabilities Act.
 - 2. ADAAG: Americans with Disabilities Act Accessibility Guidelines.
 - 3. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME B18.21.1 – Lock Washers (Inch Series).
 - b. ASME B18.22.1 – Plain Washers.
 - 2. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO Standard Specifications for Highway Bridges.
 - 3. American Welding Society (AWS):
 - a. AWS A2.1 WC & DC – Welding Symbol Charts.
 - b. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - c. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
 - d. AWS D1.3 - Structural Welding Code–Sheet Steel.



- e. AWS D1.6 - Structural Welding Code—Stainless Steel.
- f. AWS WHB-All - Welding Handbooks.
- 4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
 - d. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - e. ASTM A 510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - f. ASTM A 510M - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel [Metric].
 - g. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - h. ASTM A 563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric].
 - i. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - j. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - k. ASTM B 308/B 308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - l. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - m. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- 5. City of Phoenix (COP):
 - a. Development Services Department (DSD):
 - 1) Approved Steel Fabricators List,
<http://phoenix.gov/DEV/SERV/steelfab.pdf>.
 - b. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. ICC/ANSI A117.1 – Accessible and Usable Buildings and Facilities.
- 7. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
 - b. Metal Bar Grating Division (MBG):
 - 1) ANSI/NAAMM MBG 531 - Metal Bar Grating Manual.
 - 2) ANSI/NAAMM MBG 532 - Heavy-Duty Metal Bar Grating Manual.
- 8. Society for Protective Coatings (SSPC):



- a. SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
- 9. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
 - b. United States Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - c. United States General Services Administration (GSA):
 - 1) Federal Specifications:
 - a) TT-P-645 - Primer, Paint, Zinc-Molybdate, Alkyd Type.
 - b)
- 10. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation of anchorages for gratings, grating frames, and supports.
 - a. Deliver the anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, to the Site allowing ample time for their installation so the Work of the Contract is not delayed.
- B. Sequencing:
 - 1. Sequence the installation of metal gratings to follow construction of supporting concrete and masonry load bearing walls and concrete foundations.
 - 2. Deliver concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry so they can be incorporated into the Work in time to not delay the Work.
- C. Scheduling:
 - 1. Coordinate the grating fabrication schedule with construction progress to avoid delays to the Work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Shop and touchup paint systems.



- 2) Clips and anchorage devices for gratings.
 - b. Shop Drawings:
 - 1) Grating.
 - c. Samples:
 - 1) Stainless steel grating.
 - 2) Fiberglass Grating
 - d. Certificates:
 - 1) Mill certificates for stainless steel sheet products.
 - e. Delegated Design Submittals:
 - 1) Structural analysis data.
 - f. Qualification Statements:
 - 1) Professional Engineer's qualifications.
 - 2) Welding procedure qualification test records (PQRs).
 - 3) Welding procedure specifications (WPSs).
 - 4) Welding Certificates.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Test reports for expansion anchors used in non-structural applications.
 - b. Manufacturer's Instructions:
 - 1) Setting drawings, templates, and directions for installing anchorages specified for installation under other Sections.
 - 2) Stainless steel grating manufacturer's published installation instructions.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied primer.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Stainless Steel Grating Warranty.
 - 2) Fiberglass Grating Warranty.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 - 1. Professional Engineer's Qualifications:
 - a. Employ a qualified Professional Engineer, licensed in the State of Arizona and capable of performing a structural engineering analysis of the manufacturer's standard units similar to those proposed for the Work of this Contract, to prepare a complete structural design for the grating Work under this Contract, including required sub-framing.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.
 - 2. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and AWS D1.6, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welder Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for qualifying welders and welding procedures to the Program/Project Manager for approval.
 - a) For all procedures, other than those set forth in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and AWS D1.6, submit a copy of the welding procedure qualification test records (PQRs) and welding procedure specifications (WPSs) to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and/or AWS D1.6 for the procedures to be used.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified in accordance with the American Welding Society (AWS) standards within the previous 12 months to the Program/Project Manager for approval.



- a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- C. Certifications:
 - 1. Mill Certificates:
 - a. Submit mill certificates for the stainless steel sheet products furnished, signed by the stainless steel sheet manufacturers to certify that their products comply with requirements specified, to the Program/Project Manager for approval.
- D. Site Samples:
 - 1. Stainless Steel Grating:
 - a. Submit a 6-inch by 6-inch Sample of the stainless steel grating to the Program/Project Manager for approval.
 - b. Submit a 6-inch by 6-inch Sample of the fiberglass grating to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - 2. Provide protective wrapping on pre-finished aluminum and stainless steel products, and maintain the wrapping in place until the Contract is ready for final inspection.
- B. Storage and Handling Requirements:
 - 1. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Manufacturer Warranty:
 - 1. Have the stainless steel grating manufacturer warrant the stainless steel grating against defects in materials and workmanship within the 5-year period after the Date of Substantial Completion:
 - 2. Submit a written Stainless Steel Grating Warranty on the manufacturer's standard or customized form, without monetary limitation, in which



manufacturer agrees to repair or replace stainless steel grating that fails in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers:

1. Welded Steel Grating Manufacturer List:
 - a. Alabama Metal Industries Corporation, <http://amico-online.com>.
 - b. IKG Industries; a Harsco Company, www.ikgindustries.com.
 - c. Ohio Gratings, Inc., www.ohiogratings.com.
 - d. Fisher and Ludlow, Tru-Weld Grating, www.fisherludlow.com.
 - e. Approved equal.
2. Aluminum Grating Manufacturer List:
 - a. Ohio Gratings, Inc., Series 19SGF, www.ohiogratings.com.
 - b. Intertec Corp., AL-14 Series.
 - c. Seidelhuber Metal Products, Inc., www.seidelhuber.com.
 - d. Approved equal.
3. Stainless Steel Grating Manufacturer List:
 - a. Kadee Industries, Inc., Model KD98 Stainless Steel Floor Grate, <http://www.kadeeindustries.com>.
 - b. Approved equal.
4. Glass-Fiber-Reinforced Plastic Grating Manufacturer List:
 - a. Enduro Systems Inc.; Composite Products Division. www.endurocomposites.com
 - b. Fibergrate Composite Structures Inc. www.fibergrate.com
 - c. Fisher & Ludlow. www.fisherludlow.com
 - d. McNichols Co. www.mcnichols.com
 - e. Approved equal.
5. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Floor or ground openings in areas required to be accessible to people with disabilities are limited to 1/2 inch (13mm) in width by the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities and by ICC/ANSI A117.1.
2. Sustainability Requirements:
 - a. Recycled Content



- 1) Provide Grating whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than the values noted in the materials section of this specification section.
 - b. Low Emitting Materials – Paints and Coatings
 - 1) When paint is field applied to touch-up shop applied primer on surfaces within the building envelop, ensure they have a VOC content not exceeding 100 g/L.
- C. Performance:
 1. Structural Performance:
 - a. Provide gratings and anchors capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and under the conditions indicated in the Contract Documents:
 - 1) Floor Loads:
 - a) Design floor grates to withstand a uniform load of at least 300 pounds force per square foot, or a concentrated load of 3000 pounds force, whichever produces the greater stress.
 - (1) Concentrated loads are assumed to be applied uniformly over a 2.5-foot by 2.5-foot area to produce the maximum load effects on the grating and structural support members.
 - 2) Vehicle Loads:
 - a) Design grates in sidewalks and vehicular driveways subject to vehicular loading to withstand a uniform load of 300 pounds force per square foot, or a concentrated load of 8000 pounds force, whichever produces the greater stress.
 - (1) Concentrated loads are assumed to be applied uniformly over the standard wheel pattern as specified in the AASHTO Standard Specifications for Highway Bridges to produce the maximum load effects on the grating and structural support members.
 - 3) Maximum Stress:
 - a) Design the grating to withstand 12,000 psi for the clear span shown on the Contract Drawings.
 - 4) Maximum Deflection:
 - a) Design the grating depth for a maximum deflection of 1/4 inch under a uniform load 100 pounds per square foot.
 - b) Limit deflection to L/240 or 1/4 inch, whichever is less.
 2. Seismic Performance:
 - a. Provide gratings capable of withstanding the effects of earthquake motions determined according to Phoenix Building Construction Code and Amendments.

D. Design Criteria:



1. Unless otherwise indicated in the Construction Documents, design the grating that will be installed and mechanically fastened down to be removable.
2. Metal Bar Grating Standards:
 - a. For steel and stainless steel gratings with a maximum bearing bar depth of 2-1/2 inches (64mm) and a maximum thickness of 3/16 inch (4.8mm), and for aluminum gratings with a maximum bearing bar depth of 2-1/2 inches (64mm) and a maximum thickness of 1/4 inch, (6.4mm) comply with the requirements specified in ANSI/NAAMM MBG 531.
 - b. For steel and stainless steel gratings with a maximum bearing bar depth of 5 inches (127mm) and a thicknesses from 1/4 inch to 3/8 inch (6.4mm to 9.5mm) comply with the requirements specified in ANSI/NAAMM MBG 532.
 - c. Design the grating connections so the structural value of the joined pieces is maintained.
 - d. Provide the anchorage indicated in the Contract Drawings, and coordinate the type of anchorage with the anchorage requirements for the supporting structure.
 - 1) Provide and space the anchoring devices to secure the gratings, frames, and supports rigidly in place; and to support the loads indicated in the Contract Documents.
 - e. Design the grating so the maximum weight of any one piece of grating does not exceed 75 pounds.
3. Fiberglass Grating Standards:
 - a. For fiberglass gratings with a maximum bearing bar thickness of 1-inch, comply with the requirements specified in ASTM E84.
 - b. Design the grating connections so the structural value of the joined pieces is maintained.
 - c. Provide anchorage indicated in the Contract Drawings, and coordinate the type of anchorage with the anchorage requirements for the supporting structure.
 - 1) Provide and space the anchoring devices to secure the gratings, frames, and supports rigidly in place; and to support the loads indicated in the Contract Documents.
4. Fasteners:
 - a. Select fasteners of the type, grade, and class required.
 - b. Unless otherwise indicated in the Contract Documents, provide the following types of fasteners for metal gratings:
 - 1) For exterior applications, provide Type 316 stainless steel bolts and fasteners.
 - 2) For interior applications, provide fasteners and bolts zinc-plated in accordance with the requirements for Class Fe/Zn 5 coating specified in ASTM B 633.
 - 3) For fastening aluminum, provide stainless steel fasteners.



- c. Expansion Anchors:
 - 1) For non-structural applications, provide expansion anchor bolt and sleeve assemblies with the capability to sustain, without failure, the following loads as determined by testing conducted by a qualified independent testing agency in accordance with the requirements specified in ASTM E 488:
 - a) When installed in unit masonry, a load equal to 6 times the load imposed.
 - b) When installed in concrete, a load equal to 4 times the load imposed.
 - 2) For expansion anchors used in non-structural applications, submit test reports prepared, signed, sealed, and dated by an independent Testing and Inspection Agency, qualified in accordance with the requirements specified in ASTM E 488, to the Program/Project Manager for information.
 - 3) For structural applications, provide expansion anchor bolt and sleeve assemblies as specified in the structural Sections and indicated on the Contract Drawings.
- d. Adhesive Anchors:
 - 1) For structural applications, provide adhesive anchors as specified in the structural Sections and indicated on the Contract Drawings.
- 5. Product Data:
 - a. Submit Product Data for the following products to the Program/Project Manager for approval:
 - 1) Shop and touchup paint systems.
 - 2) Clips and anchorage devices for gratings.
- 6. Shop Drawings:
 - a. Prepare Shop Drawings for the grating proposed for the Work of this Section demonstrating compliance with the requirements of the Contract Documents.
 - 1) Include plans, layouts, elevations, sections, details, typical installations, and attachments to other work.
 - a) Show supports supplied and required by the grating manufacturer.
 - b) Include anchor requirements and anchors.
 - c) Indicate the field measurements of the slab recesses to receive the floor grating.
 - d) Indicate the types of floor grates and details of patterns or designs.
 - 2) Provide easy-to-read markings on the Shop Drawings for assemblies requiring erection or installation identification marks.
 - 3) Include tolerance variations or clearance requirements.
 - 4) Use American Welding Society standard welding symbols as shown in AWS A2.1 WC & DC.



- 5) Prepare setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry provided under other Sections to the Program/Project Manager for information.
 - a) Prepare templates for anchors and bolts specified for installation under other Sections.
 - b. Submit the Shop Drawings of the grating to the Program/Project Manager for approval.
7. Design Calculations:
 - a. For products required to comply with design loads, prepare and submit structural analysis data, signed and sealed by the qualified Professional Engineer responsible for their preparation, to the Program/Project Manager for approval.

E. Materials:

1. Ferrous Metals:
 - a. Steel Plates, Shapes, and Bars:
 - 1) Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - b. Wire Rod:
 - 1) Provide wire rod for grating crossbars complying with the requirements specified in ASTM A 510.
2. Aluminum:
 - a. Aluminum Structural Shapes:
 - 1) Provide structural shapes of rolled or extruded aluminum alloy 6061-T6 complying with the requirements specified in ASTM B 308/B 308M.
 - 2) Provide the structural shapes and thicknesses indicated on Contract Drawings.
 - b. Aluminum Rod and Bars:
 - 1) Provide rods and bars of aluminum alloy 6061-T6 complying with the requirements specified in ASTM B 221.
 - 2) Provide rods and bars having the dimensions indicated on the Contract Drawings.
 - c. Aluminum Sheet and Plate:
 - 1) Provide sheets and plates of aluminum alloy 6061-T6 complying with the requirements specified in ASTM B 209.
 - 2) Provide sheets and plates having the thicknesses indicated on Contract Drawings.
 - d. Aluminum Checkered Plate:
 - 1) Provide checkered plate of aluminum alloy 6061-T6 complying with the requirements specified in ASTM B 209.
 - 2) Provide checkered plate having the thicknesses indicated on Contract Drawings, which does not include the raised portion.
3. Stainless Steel:



- a. Stainless Steel Angles:
 - 1) Provide stainless steel angles complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- b. Stainless Steel Wire:
 - 1) Provide stainless steel wire complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- c. Stainless Steel Rods:
 - 1) Provide stainless steel wire complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- 4. Welding Rods and Bare Electrodes:
 - a. Furnish welding rods and bare electrodes selected in accordance with the requirements for the metal alloy being welded in the American Welding Society (AWS) references.

F. Manufactured Units:

- 1. Steel Grating:
 - a. Provide welded steel grating having the following features:
 - 1) Bearing Bar Spacing: Either 7/16 inch or 1/2 inch apart on center.
 - 2) Bearing Bar Depth: 1 inch, but not less than the depth required to comply with the structural performance requirements.
 - 3) Bearing Bar Thickness: 1/8 inch, but not less than the thickness required to comply with structural performance requirements.
 - 4) Crossbar Spacing: 4 inches apart on center.
 - 5) Traffic Surface:
 - a) Apply an abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.
 - 6) Steel Finish:
 - a) Provide a hot-dip galvanized coating with a weight of not less than 1.8 ounces per square foot of coated surface.
 - b. Recycled Content
 - 1) Provide Steel Grating whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
- 2. Aluminum Grating:
 - a. Provide removable type aluminum grating, fabricated to the panel sizes and thickness indicated on the Contract Drawings.
 - 1) Where panel sizes are not indicated on the Contract Drawings, limit the panel weights to a maximum of 120 pounds each.
 - 2) Bearing Bars:
 - a) Provide bearing bars fabricated from aluminum alloy 6063-T6 complying with the requirements specified in ASTM B 221.
 - 3) Cross Bars and Bent Connecting Bars:
 - a) Provide cross bars and bent connecting bars fabricated from aluminum alloy 6063-T5 complying with the requirements specified in ASTM B 221.
 - 4) Bar Spacing:



- a) Bearing Bars: Spaced 1-3/16 inches apart, center-to-center.
 - b) Cross Bars: Spaced 4 inches apart, center-to-center.
 - 5) Bar Connections:
 - a) Mechanically lock the cross bars to the bearing bars.
 - 6) Anchor Clips:
 - a) Provide galvanized steel or stainless steel saddle clips of the number recommended by manufacturer.
 - 7) Bearing Angle:
 - a) Provide aluminum bearing angles fabricated from aluminum alloy 6061-T6 complying with the requirements specified in ASTM B 308/B 308M.
 - 8) Banding:
 - a) Band the grating bar ends the same depth as the bars.
 - b) Openings cutting 2 or more bearing bars require banding.
 - c) Openings for pipes, ducts, conduits, and similar objects require banding.
 - 9) Openings through Panels:
 - a) To facilitate removal of panels at pipes, ducts, conduits, and similar objects passing through grating panels, split the panels into 2 individual sections.
 - 10) Recycled Content
 - a) Provide Aluminum Grating whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 75 percent.
- 3. Stainless Steel Grating:
 - a. Provide removable type stainless steel grating, fabricated to the panel sizes and thickness indicated on the Contract Drawings.
 - b. Stainless Steel Grating Frames:
 - 1) Provide 1-1/4 x 1-1/4 x 1/8 stainless steel angle frames having 1-1/2 x 1-1/2 x 3/16 stainless steel angle intermediate supports spaced no more than 3 feet apart.
 - c. Stainless Steel Grating Support Rods:
 - 1) Provide 0.070 inch by 1 inch stainless steel support rods spaced 1 inch apart on center.
 - d. Stainless Steel Grating Treads:
 - 1) Provide stainless steel treads consisting of 0.071-inch by 0.177-inch stainless steel surface wire inserted in slot openings in the support rods spaced 0.125-inch apart on center, and resistance welded to the support rods.
 - 2) Provide approximately 60 tread wires in 1 foot.
 - 3) Finish:
 - a) Provide tread wires having a number 4 satin finish.
 - e. Stainless Steel Grating Locking Devices:



- 1) Provide hidden locking devices complying with the stainless steel grating manufacturer's recommendations to prevent warping and rattling.
- f. Recycled Content
 - 1) Provide Stainless Steel Grating whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 33 percent.
4. Glass-Fiber-Reinforced Grating:
 - a. Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.
 - 1) Configuration: T5020; 2 inch T-bars spaced 2 inches o.c. McNichols F141611142; I-bars spaced 1.5 inches o.c.
 - 2) Resin Type: Polyester; Flame spread 25 or less when tested according to ASTM E84.
 - 3) Color: Gray
 - 4) Traffic Surface: Plain. Medium Grit surface at Roof applications.
 - b. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings. Provide support members at penetrations and cutouts to maintain design load requirements.
5. Removable Grating Sections:
 - a. Provide removable grating sections that have banding bars welded to the section's perimeter.
 - b. Provide anchors and fasteners of the type indicated in the Contract Documents; or, if not indicated, as recommended by the manufacturer for attaching the grating to its supports.
 - c. For each heavy-duty grating section, provide not less than 4 small square metal lugs, each having a hole for inserting a fastener, and shop weld each lug to 2 bearing bars.
 - d. Furnish threaded bolts with nuts and washers for securing the removable grating to its supports.
 - e. Do not notch the bearing bars at supports to maintain elevation.
6. Frames and Supports for Metal Gratings:
 - a. For metal grating not supported by structural steel, provide frames and supports fabricated by welding metal shapes, plates, and bars to the sizes, shapes, and profiles indicated in the Contract Documents and as necessary to receive the gratings.
 - 1) Unless otherwise indicated, fabricate the frames and supports from the same basic metal as the gratings are fabricated from.
 - 2) Miter and weld the connections of perimeter angle frames.
 - 3) Cut, drill, and tap the units to receive hardware and similar items.
 - 4) Galvanize steel frames and supports.



- b. For frames and supports to be cast into concrete or built into masonry, provide anchors integrally welded to the frames and supports.
 - 1) Unless otherwise indicated, space these anchors 24 inches apart on center
 - 2) At a minimum, provide steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
 - 7. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings:
 - a. Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1) Unless otherwise indicated, use shapes made from same resin as gratings.
 - 2) Equip units indicated to be cast into concrete or built into masonry with integral anchors.
 - 8. Grating Stair Treads and Landings:
 - a. For grating stair treads and landings on steel-framed stairs, provide grating complying with the requirements specified in Section 05511, Metal Stairs.
 - 9. Metal Handrails and Railings:
 - a. For metal handrails and railings, provide pipe and tube handrails and railings complying with the requirements specified in Section 05521, Pipe and Tube Railings.
- G. Assembly/Fabrication:
 - 1. Factory Assembly
 - a. Insofar as possible, fit and shop assemble metal gratings and fabrications ready for installation.
 - 1) Fabricate grating sections in the shop to the greatest extent possible to minimize field splicing and assembly.
 - a) Disassemble units only as necessary for shipping and due to handling limitations.
 - b) Clearly mark units to facilitate reassembly and coordinated installation.
 - 2. Shop Fabrication:
 - a. Fabricate metal and fiberglass gratings and fabrications in accordance with the details on the Contract Drawings, approved Shop Drawings, and referenced standards.
 - 1) Fabricate work square, plumb, straight, and true.
 - 2) Form grating sections from materials of the size, thickness, and shapes indicated in the Contract Documents, but not less than those needed to support the loads specified.
 - 3) Cut, drill, and punch material cleanly and accurately.
 - a) Unless otherwise indicated, remove burrs and ease edges to a radius of approximately 1/32 inch.
 - b) Remove sharp or rough areas on exposed surfaces.



- 4) Fit exposed connections accurately together to form hairline joints.
 - b. Drill or punch holes required for attachment of other Work and for bolted connections.
 - 1) Burned holes are unacceptable.
 - c. Welding:
 - 1) Perform welding in accordance with the requirements specified in the appropriate American Welding Society (AWS) standards for the materials being welded, and with the following:
 - a) Use materials and methods that minimize distortion and develop the strength and corrosion resistance of the base metals.
 - b) Obtain fusion without undercut or overlap.
 - c) Remove welding flux immediately.
 - d) Weld aluminum in accordance with the requirements specified in Section 4, Chapter 69 "Aluminum and Aluminum Alloys", of the AWS Handbook.
 - 2) Dress welds and sharp corners smooth.
- H. Finishes:
- 1. Primer Materials:
 - a. Zinc Chromate Primer:
 - 1) Provide zinc chromate primer complying with the requirements specified in TT-P-645.
 - 2. Finish Materials:
 - a. Galvanizing Repair Paint:
 - 1) For re-galvanizing welds in steel, provide high-zinc-dust-content paint complying with the requirements specified in SSPC-Paint 20.
 - b. Mineral filled coal tar pitch:
 - 1) Provide mineral filled coal tar pitch.
 - 2) Manufacturers:
 - a) Tnemec Company, Inc., 46-449, www.tnemec.com.
 - b) Carboline Company, www.carboline.com.
 - c) M. A. B. Paints, www.mabpaints.com.
 - d) The Sherwin-Williams Company, www.sherwin-williams.com.
 - e) Approved equal.
 - 3. Shop Finishing Methods:
 - a. Steel Finishes:
 - 1) Finish gratings, frames, and supports after assembly.
 - 2) For finish designations and application recommendations, comply with the requirements specified in NAAMM/NOMMA AMP 500.
 - 3) Galvanizing:
 - a) For those items indicated to be galvanized, apply a zinc coating by using the hot-dip process complying with the requirements specified in ASTM A 123/A 123M.
 - 4) To isolate dissimilar material surfaces from one another, paint the material interfaces with mineral filled coal tar pitch.



2.02 ACCESSORIES

A. Fasteners, Anchors, and Bolts:

1. Bolts and Nuts:
 - a. Provide regular hexagon-head steel bolts complying with the requirements specified for Grade A bolts in ASTM A 307.
 - b. Provide steel hex nuts complying with the requirements specified in ASTM A 563 (ASTM A 563M).
 - c. Provide steel flat washers where indicated in the Contract Documents.
2. Plain Washers:
 - a. Provide plain round washers complying with the requirements specified in ASME B18.22.1.
3. Lock Washers:
 - a. Provide helical, spring type lock washers complying with the requirements specified in ASME B18.21.1.
4. Lag Bolts:
 - a. Provide lag bolts complying with the requirements specified in ASME B18.2.1.
5. Anchor Bolts:
 - a. Provide Grade 36 anchor bolts complying with the requirements specified in ASTM F 1554.
6. Cast-in-Place Anchors:
 - a. Non-Structural Anchors in Concrete:
 - 1) Provide anchors capable of sustaining, without failure, a load equal to 4 times the load imposed as determined by testing conducted by a qualified independent testing agency in accordance with the requirements specified in ASTM E 488.
 - b. Non-Structural Anchors in Masonry Construction:
 - 1) Provide anchors capable of sustaining, without failure, a load equal to 6 times the load imposed as determined by testing conducted by a qualified independent testing agency in accordance with the requirements specified in ASTM E 488.
 - c. Provide either threaded or wedge type anchors.
 - d. Provide galvanized ferrous castings, either malleable iron castings complying with the requirements specified in ASTM A 47/A 47M, or cast steel castings complying with the requirements specified in ASTM A 27/A 27M.
 - e. Provide bolts, washers, and shims as required, hot-dip galvanized in accordance with the requirements specified in ASTM A 153/A 153M.
7. Expansion Anchors:
 - a. For non-structural applications in interior locations, provide carbon steel expansion anchors zinc-plated in accordance with the requirements for Class Fe/Zn 5 coating specified in ASTM B 633.
 - b. For non-structural applications in exterior locations, provide expansion anchors having Alloy Group 1 stainless steel bolts complying with the



requirements specified in ASTM F 593, and stainless steel nuts complying with the requirements specified in ASTM F 594.

- c. For structural applications, provide expansion anchor bolt and sleeve assemblies complying with the requirements specified in other structural Sections and as indicated on the Contract Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Inspect installed adjacent work to verify it is completed to the point so the gratings may be properly installed.
 - a. For level bed applications of stainless steel grating, the surfaces must be flat.
 2. Field Measurements:
 - a. Verify the actual locations of walls and other construction contiguous to the gratings and the actual block-out openings in the floors by taking accurate field measurements before fabricating the metal grating, and indicate the field measurements on the Shop Drawings.
- B. Evaluation and Assessment:
 1. Immediately report any errors in the metal gratings which will prevent the proper installation and fitting of parts.
 - a. Report errors resulting from either shop fabrication or deformation resulting from handling or transportation.
 2. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the metal gratings.
- B. Surface Preparation:
 1. Provide anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

3.03 INSTALLATION

- A. Provide metal grating in accordance with details on the Contract Drawings, approved Shop Drawings, and the referenced standards.
 1. Install gratings in accordance with the recommendations of the referenced metal bar grating standard that applies to the grating type and bar size



- indicated in the Contract Documents, including recommended installation clearances and standard anchoring details.
2. Stainless Steel Grating:
 - a. Defer the installation of stainless steel grating as much as possible until near the time of Substantial Completion.
 - b. Install stainless steel grating in accordance with the stainless steel grating manufacturer's installation instructions.
 - 1) Submit the stainless steel grating manufacturer's published installation instructions to the Program/Project Manager for information.
 3. Attach removable units to supporting members with the type and size of clips and fasteners indicated in the Contract Documents; or, if not indicated, as recommended by the grating manufacturer for the type of installation conditions shown.
 4. Where both the non-removable gratings and their supporting members have been fabricated from the same material, weld the non-removable gratings to the supporting members.
 5. Where neither the non-removable gratings and their supporting members have been fabricated from the same material, fasten non-removable units to supporting members the type and size of bolts and fasteners indicated in the Contract Documents; or, if not indicated, as recommended by the grating manufacturer for the type of installation conditions shown.
- B. Provide glass-fiber-reinforced grating in accordance with manufacturer's written instructions for installing grates. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.
- C. Provide suitable temporary braces and stays to hold work in position until it can be permanently secured.
1. Furnish temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Cutting, Fitting, and Placement:
1. Cut, drill, and fit the metal gratings as required for installation.
 2. Accurately set the metal gratings in the proper location, in the proper alignment, and at the proper elevation when measured from established lines and levels, with edges and surfaces level, plumb, true, and free of rack.
 3. Fit exposed connections accurately together to form hairline joints.
- E. Special Techniques:
1. Field Welding:
 - a. Weld connections that are not to be left as exposed joints, but that cannot be shop welded because of shipping size limitations.



- 1) Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication, or are designed for bolted or screwed field connections.
 - 2) Weld the toeplates not attached to the gratings in the shop to the gratings at the locations indicated in the Contract Documents.
 - b. Provide materials and methods that minimize distortion, and that develop the strength and corrosion resistance of the base metals.
 - c. Obtain fusion without undercut or overlap.
 - d. Remove welding flux immediately.
- F. Interface with Other Work:
1. Dissimilar Surfaces Isolation:
 - a. Paint metal surfaces at the point of contact with wood, concrete, or masonry construction with one coat of bituminous paint to a minimum dry mil thickness of 5.0 mils, or install isolators made of mylar or another approved material.
 - b. Paint aluminum surfaces at the point of contact with steel with one coat of zinc chromate primer.
 2. Fastening to In-Place Construction:
 - a. Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction.
 - b. Provide threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
 3. Expansion Anchor Installation:
 - a. Install expansion anchors in strict accordance with the manufacturer's instructions and the following.
 - 1) Drilling Holes:
 - a) Use a rotary hammer type drill to make drill holes to the required diameter and depth consistent with the anchor manufacturer's instructions for the size of the anchor being installed.
 - b) Do not cut existing reinforcement steel.
 - 2) Minimum Embedment:
 - a) Embed expansion anchors to a depth of 4-1/2 bolt diameters, unless otherwise indicated on Contract Drawings.
 - b) Apply a safety factor of 4 to the expansion bolt pullout values published by manufacturer.
- G. Tolerances:
1. Align the grating straight, plumb, and level within a tolerance of 1 in 200.

3.04 CLEANING

- A. Clean away excess or misplaced paint materials from railing surfaces and adjoining construction materials.



B. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

A. Protect installed grating products until the Work of the Contract is completed.

B. Stainless Steel Grating:

1. After the concrete work and stainless steel grating frame have been installed, furnish temporary plywood or fiberboard filler in the grate recesses, and cover the frames with protective plywood flooring until construction traffic has ceased and the Contract time nears Substantial Completion..

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 05580

FORMED METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for formed metal fabrications, including the following:
 - a. Metal panel cladding.
 - b. Metal panel beam wrap.
 - c. Metal column cover.
 - d. Baggage cart protection rail.
 - e. Corner guards.
 - f. Base.
 - g. Break metal shapes.
 - h. Metal panel escalator cladding.
 - i. Metal panels soffits and bulkheads.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01454 - Mock-Up Requirements.
 - 4. Section 01732 - Cutting and Patching.
 - 5. Section 01780 - Closeout Submittals.
 - 6. Section 09912 – Painting.
 - 7. Section 09960 - High-Performance Coatings.
 - 8. Section 09961 - Fluoropolymer Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. MSDS: Material safety data sheets.
 - 3. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 4. URL: Uniform resource locator.



5. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Reference Standards:

1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
 - b. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
 - c. AWS D1.3 - Structural Welding Code–Sheet Steel.
 - d. AWS D1.6 - Structural Welding Code–Stainless Steel.
4. ASTM International (ASTM):
 - a. ASTM A 29/A 29M – Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for.
 - b. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - c. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
 - d. ASTM A 312/A 312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - e. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - f. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - g. ASTM A 554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
 - h. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
 - i. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - j. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - k. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - l. ASTM B 210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.



- m. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- n. ASTM B 483/B483 M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tube and Pipe for General Purpose Applications.
- o. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- p. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
- q. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- r. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. Green Seal, Inc. (GS):
 - a. GC-03 - Green Seal™ Environmental Criteria for Anti-Corrosive Paints.
 - b. GS-11 – Green Seal™ Environmental Standard for Paints and Coatings.
- 7. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 8. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA 500 – Metal Finishes Manual for Architectural and Metal Products.
- 9. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1113 – Architectural Coatings.
 - b. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 10. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC–PA 1 – Paint Application Specification No. 1 Shop, Field, and Maintenance Painting of Steel.
 - 2) SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
- 11. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 12. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of anchorages for architectural metal items.
 - a. Furnish setting drawings, templates, and directions for installing the anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
 - 1) Deliver these items to the Site in time for installation.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Metal panel cladding.
 - 2) Metal panel beam wrap.
 - 3) Metal column cover.
 - 4) Baggage cart protection rail.
 - 5) Corner guards.
 - 6) Base.
 - 7) Break metal shapes.
 - 8) Metal panel escalator cladding.
 - 9) Metal panels soffits and bulkheads.
 - 10) Material Safety Data Sheets (MSDS)
 - b. Shop Drawings:
 - 1) Formed metal fabrications.
 - c. Samples:
 - 1) Samples of each type of exposed finish specified.
 - 2) Samples of the specified finishes for panel edge extrusions.
 - 3) Mock-up Samples of the wall systems.
 - d. Certificates:
 - 1) Stainless-steel mill certificates.
 - e. Qualification Statements:
 - 1) Formed metal fabrications fabricator's and installer's qualifications.
 - 2) Formed metal fabrications manufacturer's qualifications.
 - 3) Anodic finisher's qualifications.
 - 4) Powder-coating applicator's qualifications.
 - 5) Welding procedure specifications (WPS) test records.
 - 6) Procedures to be used for pre-qualifying welders.
 - 7) Welding Certificates.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Formed metal fabrication manufacturer's written installation instructions.
 - 2) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 3) Paints and Coatings
 - a) Submit product data highlighting the VOC content for any field applied paint used to touch-up shop applied prime
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Manufacturer's maintenance instructions for the formed metal fabrications.
 - b. Warranty Documentation:
 - 1) Formed Metal Fabrications Warranty.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Formed Metal Fabrications Fabricator's and Installer's Qualifications:
 - a. To fabricate and install the formed metal fabrications required for the Work of this Section, employ a firm experienced in producing architectural metal similar to that required for this Contract, and whose work has a record of successful in-service performance
 - 1) Employ a firm having sufficient production capacity to produce quantity of units required.
 - 2) Arrange to have the same firm that fabricates the formed architectural metal fabrications for this Contract to install those fabrications
 - a) The installation firm must have a minimum of 3 years' experience installing wall systems similar to those required as the Work of this Section.
 - b. Submit the formed metal fabrications fabricator's and installer's qualifications to the Program/Project Manager for approval.
 2. Formed Metal Fabrications Manufacturer's Qualifications:
 - a. To manufacture the formed metal fabrications, select a firm having a minimum of 10 years' experience manufacturing architectural surface



- materials and a minimum of 10 years' experience fabricating wall systems.
- b. Submit the formed metal fabrications manufacturer's qualifications to the Program/Project Manager for approval.
 - 1) Include a reference list of at least 20 public space projects currently using walls fabricated by the manufacturer.
 - 2) Include overview literature describing the manufacturer's overall scope of products and manufacturing capabilities.
 - 3) Include the URL for the manufacturer's web site.
 - a) The web site must provide access to technical data, images, and general product information.
 3. Anodic Finisher's Qualifications:
 - a. To apply the anodic finishes to aluminum as required for the Work of this Section, employ a firm experienced in successfully applying anodic finishes of the types indicated, and that employs competent control personnel to conduct a continuing, effective quality control program to ensure compliance of the anodic finishes with the specified requirements.
 - b. Submit the anodic finisher's qualifications to the Program/Project Manager for approval.
 4. Powder-Coating Applicator's Qualifications:
 - a. To apply the powder-coating finishes required for the Work of this Section, employ a firm experienced in successfully applying powder coatings of the types indicated, and that employs competent control personnel to conduct a continuing, effective quality control program to ensure compliance of the powder-coatings with the specified requirements.
 - b. Submit the powder-coating applicator's qualifications to the Program/Project Manager for approval.
 5. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, or AWS D1.6 submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures.



- 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- B. Certifications:
1. Mill Certificates:
 - a. Submit stainless-steel mill certificates, signed by the manufacturer of the stainless-steel products, certifying the products provided comply with the specified requirements.
 - 1) Certify the material provided conforms to the appropriate ASTM specification.
- C. Site Samples:
1. Samples for Verification:
 - a. For products involving the selection of a color, texture, or design, including mechanical finishes, Samples are required for verification of the color, texture, or design.
 - 1) For each type of exposed finish specified, submit Samples not less than 4 inches by 4 inches in size.
 - 2) For panel edge extrusions, submit Samples of the specified finishes not less than 4 inches long.
 - 3) Submit mock-up Samples of the wall systems not less than 12 inches by 12 inches in size.
- D. Mock-Ups:
1. After the Samples have been approved, build mockups of the following types of architectural metal in accordance with the requirements specified in Section 01454, Mock-Up Requirements, to verify the selections made under the Sample submittals, and to demonstrate the aesthetic effects and set the quality standards for fabrication and installation of the formed metal fabrications:
 - a. Metal beam wraps.
 - b. Metal column.
 - c. Baggage cart protection rail.
 - d. Metal panel escalator cladding.
 - e. Stainless steel guardrails.
 2. Build the mockups in the locations and of the size indicated on the Contract Drawings; or, if not indicated, as directed by Program/Project Manager.



3. Build architectural metal mockups that include all the types of components required by the system and that match the systems' components, and use the installation methods to be used to install the production Work to install the mock-ups.
4. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver formed metal fabrications materials to the Site in their manufacturer's original packaging.
2. Deliver cast-metal products in wooden crates surrounded by sufficient packing material to ensure that the products will not be cracked or otherwise damaged.
3. Protect finished surfaces with strippable film.

B. Storage and Handling Requirements:

1. Store architectural metal inside a well-ventilated area, away from uncured concrete and masonry; and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
2. Store formed metal fabrications products in a dry, secure location, protected against direct sunlight and excessive heat.
3. Store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that the products will not be cracked or otherwise damaged.
4. Handle formed metal fabrications products in accordance with their manufacturer's instructions.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Warrant the formed metal fabrications against defects in materials and workmanship within the 1 year period after the Date of Substantial Completion:
2. Submit the written Formed Metal Fabrications Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured formed metal fabrications that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.



- a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 FORMED METAL FABRICATIONS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Adhesives, Sealants, and Sealant Primers:
 - 1) Provide adhesives, sealants, and sealant primers for the interior formed metal fabrications of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) For drywall and panel adhesives: Not more than 50 grams per Liter less water.
 - b) For cove base adhesives: Not more than 50 grams per Liter less water.
 - c) For multipurpose construction adhesives: Not more than 70 grams per Liter less water.
 - d) For contact adhesive: Not more than 80 grams per Liter less water.
 - e) For special purpose contact adhesive: Not more than 250 grams per Liter less water.
 - f) For top and trim adhesive: Not more than 250 grams per Liter less water.
 - g) For metal to metal: Not more than 30 grams per Liter less water.



- h) For architectural sealants: Not more than 250 grams per Liter less water.
 - i) For other non-roof and non-roadway sealants: Not more than 420 grams per Liter less water.
 - j) For architectural non-porous sealant primers: Not more than 250 grams per Liter less water.
 - b. Volatile Organic Compounds (VOC) Content of Field-Applied Interior Paints and Coatings:
 - 1) Provide paint products having volatile organic compound content, exclusive of colorants added to a tint base, not greater than the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - a) Paints & Coatings: Not more than 50 grams per Liter.
 - b) Primers: Not more than 100 grams per Liter.
 - c) Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: Not more than 100 grams per Liter.
 - c. Recycled Stainless Steel and Aluminum:
 - 1) Provide stainless steel and aluminum with the following percentages of recycled stainless steel and aluminum:
 - a) Post-industrial recycled content: 46 percent, minimum.
 - b) Post-consumer recycled content: 25 percent, minimum.
 - c) Total recycled content: Not less than 71 percent.
 - 2) Submit written affidavits from the stainless steel and aluminum manufacturers verifying that the recycled stainless steel and aluminum content provided complies with the specified requirements.
- C. Performance:
 - 1. Anchors:
 - a. Provide anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry, and equal to 4 times the load imposed when installed in concrete, as determined when tested by a qualified independent testing agency in accordance with the method specified in ASTM E 488.
- D. Design Criteria:
 - 1. The wall panel layout and reveal spacing are indicated on the Contract Drawings.
 - 2. Product Data:
 - a. For each type of formed metal fabrications product proposed for the Work of this Section, obtain the manufacturer's Product Data, including finishing materials.
 - b. Material Safety Data Sheets (MSDS):
 - 1) For each of the following products applied onsite and in the interior of the building, obtain the manufacturer's Material Safety Data Sheets (MSDS):



- a) Adhesives and sealants.
 - b) Paints and coatings.
 - c. Submit the Product Data and material safety data sheets (MSDS) for the formed metal fabrications to the Program/Project Manager for approval.
 - 3. Shop Drawings:
 - a. Prepare Shop Drawings for the formed metal fabrications, including plans, elevations, component details, and attachments to other work.
 - 1) Show fabrication and installation details that indicate the materials and profiles of each architectural metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
 - 2) Include the manufacturer's installation drawings.
 - a) Provide templates for anchors and bolts specified for installation under other Sections.
 - b. Submit the Shop Drawings for the formed metal fabrications to the Program/Project Manager for approval.
- E. Materials:
- 1. Metals:
 - a. Metal Surfaces:
 - 1) Provide metal materials having smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
 - b. Aluminum:
 - 1) Provide aluminum alloy and tempers recommended by the aluminum producer and finisher for the type of use and finish indicated in the Contract Documents, and having the strength and durability for each aluminum form required of not less than that of the alloy and temper designated for the items as follows:
 - a) Extruded Bars and Shapes:
 - (1) Provide extruded aluminum bars and shapes complying with the requirements for aluminum Alloy 6063-T5/T52 specified in ASTM B 221.
 - b) Drawn Seamless Tubing:
 - (1) Provide Drawn Seamless Aluminum Tubing complying with the requirements for aluminum Alloy 6063-T832 specified in ASTM B 210 or ASTM B 483/B483 M.
 - c) Plate and Sheet:
 - (1) Provide aluminum plate and sheet complying with the requirements for aluminum Alloy 5005-H32 specified in ASTM B 209.
 - c. Stainless Steel:
 - 1) Provide stainless steel of the type indicated for the following items:
 - a) Tubing:



- (1) Provide stainless steel tubing complying with the requirements for Grade MT 304 stainless steel specified in ASTM A 554.
 - b) Pipe:
 - (1) Provide stainless steel pipe complying with the requirements for Grade TP 304 stainless steel specified in ASTM A 312/A 312M.
 - c) Sheet, Strip, Plate, and Flat Bar:
 - (1) Provide stainless steel sheets, strips, plates, and flat bars complying with the requirements for Type 304 stainless steel specified in ASTM A 666.
 - d) Bars and Shapes:
 - (1) Provide stainless steel bars and shapes complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- d. Carbon Steel and Iron:
 - 1) Provide carbon steel and iron of the type indicated for the following items:
 - a) Tubing:
 - (1) Provide carbon steel and iron tubing sheets complying with the requirements for cold formed tubing specified in ASTM A 500 or with the requirements for Type 5 (mandrel drawn) tubing specified in ASTM A 513.
 - b) Bars:
 - (1) Provide hot-rolled carbon steel bars complying with the requirements for Grade 1010 carbon steel bars specified in ASTM A 29/A 29M.
 - c) Plates, Shapes, and Bars:
 - (1) Provide carbon steel and iron plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - d) Steel Sheet, Cold Rolled:
 - (1) Provide cold rolled carbon steel sheets complying with the requirements either for commercial steel, Type B, or structural steel, Grade 25, exposed, specified in ASTM A 1008/A 1008M.
- 2. Fasteners and Hardware:
 - a. Unless otherwise indicated in the Contract Documents, provide architectural fastener and hardware fabricated from the following materials as appropriate for the materials being fastened:
 - 1) For fastening aluminum Items, provide stainless steel fasteners.
 - 2) For fastening stainless steel Items, provide stainless steel fasteners.



- 3) For fastening concealed uncoated steel Items, provide steel fasteners plated in accordance with the requirements for a Class Fe/Zn 25 electrodeposited zinc coating specified in ASTM B 633.
- 4) For fastening exposed uncoated steel Items, provide stainless steel fasteners.
- 5) For fastening dissimilar metals, provide stainless steel fasteners.
- b. Fasteners for Anchoring to Other Construction:
 - 1) Unless otherwise indicated in the Contract Documents, select fasteners of a type, grade, and class required to produce connections suitable for anchoring the formed metal fabrications to the other types of construction shown.
 - 2) For interconnecting components and for attaching architectural metal items to other work, provide concealed fasteners unless otherwise indicated in the Contract Documents.
 - 3) For exposed fasteners, provide square or hex socket flat-head machine screws unless otherwise indicated in the Contract Documents.
3. Anchors:
 - a. Provide cast-in-place, chemical, or torque-controlled expansion anchors fabricated from corrosion-resistant materials.

F. Wall Panels:

1. Panel Systems:
 - a. Provide an interlocking grid panel system having inset panels mounted in extruded aluminum frames on a fire-rated structural backer.
 - 1) Configure the panels in float style panel frames.
 - b. Stainless Steel Panels (W-3 and W-9):
 - 1) Face Panels:
 - a) Provide 19 gage (0.8mm) stainless steel face panels complying with the requirements for Type 304 stretcher leveled stainless steel specified in ASTM A 666.
 - 2) Cores:
 - a) Provide commercial grade aluminum honeycomb cores complying with the requirements for the alloy 3000 series, and having cell depths as required to produce a 1-1/4 inch thick panel.
 - 3) Backing Sheets:
 - a) Provide 20 gage stainless steel backing sheets complying with the requirements for Type 304 stretcher leveled stainless steel specified in ASTM A 666.
 - 4) Provide individually accessible panels as indicated on the Contract Drawings.
 - c. Aluminum Panels (W-1):
 - 1) Provide aluminum panels complying with the requirements for an alloy and temper as recommended by aluminum producer



- specified in ASTM B 209 or ASTM B 209M, and that are at least 0.063 inch thick.
- 2) Provide individually accessible panels as indicated on the Contract Drawings.
- 3) Finish:
 - a) Provide panels having a 3-coat fluoropolymer finish complying with the requirements specified in Section 09961, Fluoropolymer Coatings, and approved by the Program/Project Manager.
- d. Stainless Steel Base (B-2):
 - 1) Provide 11 gage stainless steel base complying with the requirements for Type 304 stretcher leveled stainless steel specified in ASTM A 666.
 - 2) Provide fabricated base having a solid backing on the inside of the base as indicated on the Contract Drawings.
- 2. Mounting Frames and Tracks;
 - a. Provide mounting frames and tracks fabricated from the following components:
 - 1) Vertical Hat Channels:
 - a) Provide extruded, anodized aluminum vertical hat channels complying with the requirements for aluminum Alloy 6063-T5/T52 specified in ASTM B 221, and having a matte black finish.
 - 2) Horizontal Mounting Tracks:
 - a) Provide extruded, anodized aluminum horizontal mounting tracks complying with the requirements for aluminum Alloy 6063-T5/T52 specified in ASTM B 221, and having a matte black finish.
 - 3) Corners and Reveals:
 - a) Provide extruded, anodized aluminum corners complying with the requirements for aluminum Alloy 6063-T5/T52 specified in ASTM B 221, and having a matte black finish; or provide stainless corners and reveals; as approved by the Program/Project Manager.
- 3. Manufacturers:
 - a. Rigidized Metals Corp. Honeycomb Core Reveal Joint Style Interior Panel Systems; Pattern: 5HR, Material: 304 SS, Finish: Sand-TeX, Gauge: 0.036", <http://www.rigidized.com>.
 - b. Environmental Interiors, Inc., <http://www.environmentalinteriors.com>.
 - c. Lindner USA, <http://www.lindnerusa.com>.
 - d. Approved equal.
- G. Assembly/Fabrication:
 - 1. Factory Assembly
 - a. To minimize field splicing and assembly, assemble formed metal fabrications in the shop to greatest extent possible.



- 1) Disassemble formed metal units only as necessary to accommodate shipping and handling limitations.
 - 2) Clearly mark formed metal units to facilitate reassembly and coordinated installation.
 - 3) Provide connections that maintain the structural value of the joined pieces.
2. Shop Fabrication:
- a. Form the architectural metal to the required shapes and sizes, true to line and level with true curves and accurate angles and surfaces.
 - 1) Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
 - 2) Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.
 - 3) In bars and extruded shapes, form simple and compound curves by bending the members in jigs that produce uniform curvature for each configuration required and maintain the cross section of the member throughout the entire bend without buckling, twisting, cracking, or otherwise deforming the exposed surfaces.
 - b. Cut, drill, and punch metals cleanly and accurately.
 - 1) Unless otherwise indicated in the Contract Documents, remove burrs and ease edges to a radius of approximately 1/32 inch.
 - 2) Remove sharp or rough areas on exposed surfaces.
 - 3) Unless otherwise indicated in the Contract Documents, cut, reinforce, drill, and tap as required to receive finish hardware, screws, and similar items.
 - c. Mill joints to a tight, hairline fit.
 - 1) Cope or miter corner joints.
 - 2) Fabricate connections that will be exposed to the weather so water will be excluded.
 - d. Provide the rebates, lugs, and brackets necessary to assemble the units and to attach them to other work.
 - e. Where cutting, welding, and/or grinding were required for proper shop fitting and jointing of architectural metal, restore the finishes so evidence of such corrective work is eliminated.
 - 1) Do not cut or abrade finishes that cannot be completely restored in the field.
 - f. For recommended shop welding practices, comply with the requirements specified in the American Welding Society (AWS) standards.
 - 1) Weld behind finished surfaces without distorting or discoloring the exposed side.
 - 2) Clean the exposed welded joints of flux, and dress the exposed and contact surfaces.

H. Finishes:

1. Primer Materials:



- a. Universal Shop Primer for Ferrous Metal:
 - 1) Provide an acrylic multipurpose primer complying with the requirements specified in Section 09912, Painting.
 - 2) Provide a primer containing pigments that make it easily distinguishable from zinc-rich primer.
- b. Zinc-Rich Primer:
 - 1) Provide a zinc-rich primer complying with the requirements specified in Section 09960, High-Performance Coatings, and that is compatible with the topcoats.
- 2. Finish Materials:
 - a. Aluminum Finishes:
 - 1) Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in AA DAF-45.
 - 2) Class I, Clear Anodic Finish:
 - a) Provide an AA-M12C22A41 finish (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018mm or thicker) complying with the requirements specified in AAMA 611.
 - b) Powder-Coat Anodic Finish:
 - (1) Provide powder-coat anodic finishes matching the finishes of the approved Samples.
 - 3) High-Performance Organic Finish (3-Coat Fluoropolymer):
 - a) Provide an AA-C12C40R1x finish (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Conversion coatings; Organic Coating: Manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, barrier coat, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight) as specified in Section 09961, Fluoropolymer Coatings.
 - b) Color and Gloss:
 - (1) Provide high-performance organic finishes having the color and gloss matching the finishes of the approved Samples.
 - b. Stainless Steel Finishes:
 - 1) Directional Satin Finish:
 - a) Provide 120-grit to 150-grit polishing materials.
 - c. Steel and Iron Finishes:
 - 1) High-Performance Intermediate Coating:
 - a) Provide a high-build urethane or epoxy intermediate coating recommended by the manufacturer for application over the



- specified zinc-rich primer and under the specified high-performance top coating.
- b) Manufacturers:
 - (1) Benjamin Moore and Co.; M73/M75 Aliphatic Acrylic Urethane Semi-Gloss, <http://www.benjaminmoore.com>.
 - (2) Carboline Company; Carboguard890 2-Component Epoxy, <http://www.carboline.com>.
 - (3) ICI Paints, Devoe® High Performance Coatings, Devthane® 378 Aliphatic Urethane Semi-Gloss Enamel, <http://www.devoecoatings.com>.
 - (4) PPG Architectural Finishes, Inc., Aquapon 97-130 Epoxy, <http://www.ppg.com>.
 - (5) The Sherwin-Williams Company, Macropoxy HS High Solids Epoxy, <http://www.sherwin-williams.com>.
 - (6) Tnemec Company, Inc., Series 27 Hi-Build Epoxy, <http://www.tnemec.com>.
 - (7) Approved equal.
 - 2) High-Performance Top Coating:
 - a) Provide a high-build, semi-gloss polyurethane enamel top coating.
 - b) Manufacturers:
 - (1) Benjamin Moore and Co.; M73/M75 Aliphatic Acrylic Urethane Semi-Gloss, <http://www.benjaminmoore.com>.
 - (2) Carboline Company; Carbothane 133 HB Aliphatic Polyurethane, <http://www.carboline.com>.
 - (3) ICI Paints, Devoe® High Performance Coatings, Devthane® 378 Aliphatic Urethane Semi-Gloss Enamel, <http://www.devoecoatings.com>.
 - (4) PPG Architectural Finishes, Inc., Aquapon 95-612 Semi-Gloss Polyurethane, <http://www.ppg.com>.
 - (5) The Sherwin-Williams Company, Corothane II Satin B65-200 Series, <http://www.sherwin-williams.com>.
 - (6) Tnemec Company, Inc., Series 1075 Endura-Shield, <http://www.tnemec.com>.
 - (7) Approved equal.
 - d. Bituminous Paint:
 - 1) Provide a cold-applied asphalt emulsion complying with the requirements specified in ASTM D 1187.
 - 3. Shop Finishing Methods:
 - a. For recommendations relative to applying and designing finishes, comply with the recommendations specified in NAAMM/NOMMA 500.
 - b. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - c. Aluminum Finishes:



- 1) Prepare and pretreat exposed metal surfaces, and apply the specified coatings in accordance with the requirements specified in AAMA 2605 and with coating and resin manufacturers' written instructions.
- d. Stainless Steel Finishes:
 - 1) Remove tool and die marks and stretch lines, or blend them into the finish.
 - 2) For formed stainless steel fabrications, provide the finishes indicated in Table 05580-1.

Table 05580-1 Stainless Steel Fabrication Finishes	
Stainless Steel Fabrication	Finish
W-3 stainless steel panels	Sand-Tex with 5HR Pattern ⁽¹⁾
W-9 stainless steel panels	Sand-Tex ⁽¹⁾
Baggage cart protection rail	No. 4 finish
Corner guards	No. 4 finish
Base	No. 4 finish
1. Finish and pattern specified in this table is the Basis-of-Design finish and pattern available from Rigidized Metals Corp.	

- 3) Directional Satin Finish:
 - a) Unless otherwise indicated in the Table 05580-1, grind and polish the surfaces to produce a uniform Number 4 sheet finish, free of cross scratches.
 - b) Run the grain of directionally textured finishes with the long dimension of each piece unless otherwise indicated.
 - c) When the polishing is completed, passivate and rinse the surfaces.
 - d) Remove embedded foreign matter, and leave the surfaces chemically clean.
- e. Steel and Iron Finishes:
 - 1) Preparation for Shop Priming:
 - a) Prepare uncoated ferrous-metal surfaces in accordance with the requirements specified in SSPC-SP 6/NACE No. 3 for the environmental exposure conditions of the installed architectural metal.
 - 2) Factory-Primed Finish:
 - a) Immediately after cleaning and pretreatment, apply an air-dried primer to surfaces that will be exposed after assembly and installation, and to concealed, non-galvanized surfaces,



to produce a minimum dry film thickness of 2 mils from each applied coat.

- 3) Painted Finish:
 - a) Provide painted finishes complying with the requirements specified in Section 09912, Painting.
- 4) High-Performance Coating Finish:
 - a) Provide high-performance coating finishes complying with the requirements specified in Section 09960, High-Performance Coatings.
 - b) Apply intermediate and finish coats to surfaces of railings primed with zinc-rich primer.
 - (1) For shop painting, comply with the coating manufacturer's written directions and with the requirements specified in SSPC-PA 1,
 - (2) Apply the intermediate coat at the spreading rate recommended by the manufacturer to achieve a dry film thickness of 3.0 mils to 8.0 mils for epoxy intermediate coats, and 1.5 mils to 4.0 mils for aliphatic urethane intermediate coats.
 - (3) Apply the topcoat at the spreading rate recommended by the manufacturer to achieve a dry film thickness of 1.5 mils to 4.0 mils.
 - (4) Match the color, texture, and coverage of the approved Samples.
 - (5) Remove and refinish, or recoat work that does not comply with the specified requirements.

2.02 ACCESSORIES

- A. Welding Rods and Bare Electrodes:
 1. Provide welding rods and bare electrodes selected in accordance with the requirements specified in the American Welding Society (AWS) welding specifications for the metal alloy welded.
 2. For aluminum, provide welding rods and bare electrodes of the type and alloy recommended by the producer of the metal to be welded as required to produce a color match, the strength, and the compatibility required in the fabricated items.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the formed metal fabrications installer present, examine the areas and conditions where this architectural metal will be installed for



compliance with the installation tolerance requirements and other conditions affecting the performance of the architectural metal.

2. Field Measurements:
 - a. Before fabricating the formed metal fabrications, verify the actual locations of walls and other construction contiguous with architectural metal by taking field measurements; and indicate the field measurements on the Shop Drawings.
- B. Evaluation and Assessment:
 1. Proceed to install the formed metal fabrications only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas, wall finishes, fixtures, and equipment from damage resulting from installation of the formed metal fabrications.
- B. Surface Preparation:
 1. Provide anchorage devices and fasteners where needed to secure the architectural metal to in-place construction.
 2. For items to be built into concrete, masonry, or similar construction, provide temporary bracing or anchors in the formwork.
- C. Demolition/Removal:
 1. Perform cutting, drilling, and fitting as required to install the architectural metal.
 - a. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install the formed metal fabrications in accordance with manufacturer's installation instructions.
 1. Submit the formed metal fabrication manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Set the formed metal fabrications products accurately at the locations indicated in the Contract Documents, and to the proper alignment and elevations measured from established lines and levels, in accordance with the manufacturer's installation instructions.
 1. Fit exposed connections accurately together to form tight, hairline joints; or, where indicated in the Contract Documents, with uniform reveals and spaces for sealants and joint fillers.
 2. Install concealed gaskets, joint filler, insulation, and flashings as the work progresses.



C. Field Welding:

1. Perform field welding in accordance with the applicable American Welding Society (AWS) specification for the procedures applying to manual shielded metal arc welding, for the requirements for appearance and quality of welds, and for the methods used to correct welding work.
2. Weld connections that are not to be left as exposed joints, but that cannot be shop welded because of shipping size limitations.
3. Grind exposed welded joints smooth, and restore the finish so it matches the finish of adjacent surfaces.

D. Corrosion Protection:

1. Coat the concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.04 REPAIR/RESTORATION

A. Restore protective coverings that have been damaged during shipment or installation.

B. Touchup Painting:

1. Restore finishes damaged during the installation and construction period in a manner so no evidence remains of the correction work.
2. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint the exposed areas with the same material originally applied to the surfaces.

C. Return items with abraded finishes that cannot be completely restored in the field to the shop so the required alterations can be made and followed by complete refinishing, or provide new units as required.

3.05 CLEANING

A. Clean the exposed surfaces in accordance with the manufacturer's cleaning instructions.

1. Unless otherwise indicated in the manufacturer's instructions, clean the metals by washing them thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
2. Submit the manufacturer's written cleaning instructions to the Program/Project Manager for information

B. Remove strippable film and other protective coverings at the time of Substantial Completion.

C. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.06 PROTECTION

- A. Protect exposed surfaces from damage by subsequent construction.
 - 1. Protect the finishes of the architectural metal from damage during the construction period using temporary protective coverings approved by the architectural metal fabricator.
- B. Retain protective coverings intact.
 - 1. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
 - 2. Remove coverings simultaneously from similarly finished items to preclude non-uniform oxidation and discoloration.

3.07 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish the manufacture's maintenance instructions for the formed metal fabrications for inclusion in operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 - 2. Submit the maintenance instructions for the formed metal fabrications to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 05700

ORNAMENTAL METAL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for ornamental metal as indicated on the Contract Drawings, including but not limited to the following types:
 - a. Ornamental metal grilles.
 - b. Ornamental metal clad doors and frames.
 - c. Combination hall push-button stations.
 - d. Exterior façade panels.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01454 - Mock-Up Requirements.
 - 4. Section 01732 - Cutting and Patching.
 - 5. Section 05580 - Formed Metal Fabrications.
 - 6. Section 09912 – Painting.
 - 7. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. PVDF: Polyvinylidene fluoride, a highly non-reactive and pure thermoplastic fluoropolymer.
- B. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.



- b. AAMA 2603 – Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
- c. AAMA 2604 – Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
- d. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- 3. American Welding Society (AWS):
 - a. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.
 - b. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - c. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
 - d. AWS D1.3 - Structural Welding Code–Sheet Steel.
 - e. AWS D1.6 - Structural Welding Code–Stainless Steel.
- 4. ASTM International (ASTM):
 - a. ASTM A 29/A 29M – Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for.
 - b. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - c. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
 - d. ASTM A 48/A 48M – Standard Specification for Gray Iron Castings.
 - e. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - g. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
 - h. ASTM A 492 - Standard Specification for Stainless Steel Rope Wire.
 - i. ASTM A 554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
 - j. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
 - k. ASTM A 743/A 743M - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
 - l. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - m. ASTM B 26/B 26M - Standard Specification for Aluminum–Alloy Sand Castings.



- n. ASTM B 36/B 36M - Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar.
- o. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- p. ASTM B 152/B 152M - Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.
- q. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- r. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- s. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- t. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- u. ASTM B 247 - Standard Specification for Aluminum and Aluminum – Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
- v. ASTM B 247M - Standard Specification for Aluminum and Aluminum – Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings [Metric].
- w. ASTM B 249/B 249M - Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings.
- x. ASTM B 455 - Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes.
- y. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- z. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- aa. ASTM B 824 - Standard Specification for General Requirements for Copper Alloy Castings.
- bb. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
- cc. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- dd. ASTM F 594 - Standard Specification for Stainless Steel Nuts.
- ee. ASTM F 783M - Standard Specification for Staple, Handgrab, Handle, and Stirrup Rung.
- ff. ASTM F 836M - Standard Specification for Style 1 Stainless Steel Metric Nuts.
- gg. ASTM F 1941 - Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw threads(UN/UNR)).
- hh. ASTM F 1941M - Standard Specification for Electrodeposited Coatings on Threaded Fasteners [Metric].
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):



- a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. The Master Painters Institute (MPI):
 - a. MPI# 20 – Primer, Zinc Rich, Epoxy.
 - b. MPI# 25 – Cleaner, Etching, for Galvanized Metal.
 - c. MPI# 26 – Primer, Galvanized Metal, Cementitious.
 - d. MPI # 79 – Primer, Alkyd, Anti-Corrosive for Metal.
 - e. MPI# 80 – Primer, Vinyl Wash.
 - f. MPI# 134 – Primer, Galvanized, Water Based.
8. National Association of Architectural Metal Manufacturers (NAAMM) / National Ornamental and Miscellaneous Metals Association (NOMMA):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA 500 – Metal Finishes Manual for Architectural and Metal Products.
9. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
 - 2) SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
 - 3) SSPC-SP 7/NACE No. 4 - Surface Preparation Specification No. 7 Brush-off Blast Cleaning.
10. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the fabrication of metal mesh with the fabrication of Work on or in which the panels will be installed.
 2. Provide final size measurements to the manufacturer in time to avoid delaying the construction schedule.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Ornamental metal grilles.
 - 2) Ornamental -metal clad doors and frames.
 - 3) Combination hall push-button stations.
 - 4) Exterior façade panels.
 - b. Shop Drawings:



- 1) Ornamental metal fabrication and installation details.
 - 2) Architectural mesh exterior façade panels.
 - c. Delegated Design Submittals:
 - 1) Structural design calculations for the exterior façade panels.
 - d. Samples:
 - 1) Samples of each type of exposed finish required.
 - e. Qualification Statements:
 - 1) Ornamental metal manufacturer's qualifications.
 - 2) Professional Engineer's credentials.
 - 3) Welding procedure qualification test records (PQRs).
 - 4) Welding procedure specifications (WPSs).
 - 5) Welding Certificates.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Exterior façade panel manufacturer's written installation instructions.

1.05 QUALITY ASSURANCE

- A. Qualifications:
- 1. Ornamental Metal Manufacturer's Qualifications:
 - a. Obtain the ornamental metal products from a firm having the domestic engineering, manufacturing, and delivery capacity required for the Work of this Section.
 - b. Obtain the ornamental metal products from a firm having successfully completed at least 5 projects within the past 3 years of a similar size and complexity, and using similar systems, to the Work required under this Section.
 - c. Submit the ornamental metal manufacturer's qualifications to the Program/Project Manager for approval.
 - 2. Professional Engineer's Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform structural analysis required for the metal fabrication.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for approval.
 - 3. Welding Qualifications:
 - a. Prior to beginning work that requires welding, the welding procedures and welders to be employed need to be qualified in accordance with the procedures specified in AWS B2.1.
 - 1) Submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.



- 2) For all procedures, other than those set forth in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and AWS D1.6, submit a copy of the welding procedure qualification test records (PQRs) and welding procedure specifications (WPSs) to the Program/Project Manager for approval.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M, AWS D1.2/D1.2M, AWS D1.3, and/or AWS D1.6, for the procedures.
 - 1) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been certified in accordance with American Welding Society (AWS) standards within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
- B. Sustainability Standards Certifications:
 1. Recycled Content ENVISION Submittals:
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Site Samples:
 1. For each type of exposed finish required, including finishes for the exterior façade panels, submit 2 Samples that are each at least 6 inches (150mm) square and that are representative of the actual product, its color, and its patterns.
- D. Mock-Ups:



1. After the Samples have been approved, build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.
 - a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. For each custom ornamental metal casting required, furnish the patterns, models, or plaster castings.
 - c. For the exterior façade panels, provide 4 foot wide by 8 foot tall mock-ups that demonstrate the complete system, including mesh attachments, surface finishes, and system compatibility.
 - 1) During installation of the exterior façade panel mock-ups, furnish onsite engineering assistance by the Contractor's Professional Engineer.
 - d. Build ornamental metal mockups that include the ornamental metal, structural support members, fasteners, flashing and trim, and sealants matching the systems, and using the methods to be used to install production Work.
2. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Protect finished surfaces with strippable film.
 - a. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 2. Deliver ornamental metal materials to the Site in their manufacturer's original packaging.
 3. Deliver cast-metal products in wooden crates surrounded by sufficient packing material to ensure that the products will not be cracked or otherwise damaged.
- B. Storage and Handling Requirements:
 1. Store ornamental metal components inside a clean, dry, secure, well-ventilated location away from uncured concrete and masonry; and protected from the weather, direct sunlight, moisture, soiling, abrasion, extreme temperatures, and humidity.
 - a. Store ornamental metal products in their manufacturer's packaging unopened until the time of their installation.
 - 1) Wrap or otherwise protect the ornamental metal products during storage.
 - b. Store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that the products will not be cracked or otherwise damaged.
 - c. Protect fastener products from dirt and corrosion by storing them in closed containers.



- 1) Store the fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
2. Handle ornamental metal products in accordance with their manufacturer's instructions.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 ORNAMENTAL METAL

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed:
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Sustainability Requirements:
 - a. Recycled Steel Products:
 - 1) Provide ornamental metal products having an average recycled steel content so that the postconsumer recycled content plus one-half of the pre-consumer recycled content is not less than 25 percent.
 - 2) Submit written affidavits from the steel product manufacturers verifying that the recycled steel content provided complies with the specified requirements.
 - b. ENVISION Credits:
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or



volume) of materials used are from reclaimed or recycled materials.

C. Design Criteria:

1. Provide ornamental metal, including exterior façade panels, as indicated on the Contract Drawings.
2. Provide architectural mesh systems designed to withstand the design forces without permanent deformation or contacting the structure behind the mesh during peak load conditions.
3. Calculations:
 - a. Have a qualified Professional Engineer prepare structural design calculations for the exterior façade panels, and sign and seal the calculations.
 - b. Submit the structural design calculations for the exterior façade panels to the Program/Project Manager for approval.
4. Product Data:
 - a. Obtain the ornamental metal manufacturers' Product Data for each type of ornamental metal product proposed for the Work of this Section, including the following:
 - 1) Finishing materials.
 - 2) Preparation instructions and recommendations.
 - 3) Storage and handling requirements and recommendations.
 - 4) Installation methods.
 - b. Submit the ornamental metal manufacturers' Product Data to the Program/Project Manager for approval.
5. Shop Drawings:
 - a. Prepare Shop Drawings that show fabrication and installation details of the ornamental metal.
 - 1) Indicate materials, finishes, fasteners, anchorages, and accessory items.
 - 2) Architectural Mesh Exterior Façade Panels:
 - a) Provide Shop Drawings for the architectural mesh exterior façade panels that furnish the following information:
 - (1) Mesh series and pattern name.
 - (2) Panel sizes.
 - (3) Panel thickness.
 - (4) Installation details.
 - (5) Provisions for reinforcement and anchoring.
 - b. Submit the ornamental metal Shop Drawings to the Program/Project Manager for approval.

D. Materials:

1. Aluminum:
 - a. Provide aluminum alloys and tempers recommended by the aluminum producer and finisher, and having strength and durability properties



not less than those of the alloys and tempers specified for the following items:

- 1) Extruded Bars and Shapes:
 - a) Provide extruded bars and shapes complying with the requirements for aluminum Alloy 6063-T5/T52 specified in ASTM B 221 (ASTM B 221M).
- 2) Plate and Sheet:
 - a) Provide Plate and Sheet complying with the requirements for aluminum Alloy 6061-T6 specified in ASTM B 209 (ASTM B 209M).
- 3) Die and Hand Forgings:
 - a) Provide die and hand forgings complying with the requirements for aluminum Alloy Alloy 6061-T6 specified in ASTM B 247 (ASTM B 247M).
- 4) Castings:
 - a) Provide castings complying with the requirements for aluminum Alloy A356.0-T6 specified in ASTM B 26/B 26M.
2. Copper Alloys:
 - a. For the following items, provide copper alloys complying with the requirements for the alloy specified for the item:
 - 1) Extruded Shapes:
 - a) Bronze:
 - (1) Provide extruded bronze shapes complying with the requirements for copper Alloy UNS No. C38500 (architectural bronze) specified in ASTM B 455.
 - b) Brass:
 - (1) Provide extruded brass shapes complying with the requirements for Alloy UNS No. C36000 (free-cutting brass) specified in ASTM B 249/B 249M.
 - c) Nickel Silver:
 - (1) Provide extruded nickel silver shapes complying with the requirements for Alloy UNS No. C79600 specified in ASTM B 249/B 249M.
 - 2) Castings:
 - a) Bronze:
 - (1) Provide bronze castings complying with the requirements for Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) specified in ASTM B 62, or complying with the requirements for Alloy UNS No. C86500 (No. 1 manganese bronze) specified in ASTM B 584.
 - b) Brass:
 - (1) Provide brass castings complying with the requirements for Alloy UNS No. C85200 (high-copper yellow brass) specified in ASTM B 584.



- c) Copper:
 - (1) Provide copper castings that contain at least 99.9 percent copper complying with the requirements specified in ASTM B 824.
 - d) Nickel Silver:
 - (1) Provide nickel silver castings complying with the requirements for Alloy UNS No. C97300 (12 percent leaded nickel silver) specified in ASTM B 584.
- 3) Plate, Sheet, Strip, and Bars:
 - a) Bronze:
 - (1) Provide bronze plate, sheet, strip, and bars complying with the requirements for Alloy UNS No. C28000 (muntz metal, 60 percent copper) specified in ASTM B 36/B 36M.
 - b) Brass:
 - (1) Provide brass plate, sheet, strip, and bars complying with the requirements for Alloy UNS No. C26000 (cartridge brass, 70 percent copper) specified in ASTM B 36/B 36M.
 - c) Copper:
 - (1) Provide copper plate, sheet, strip, and bars complying with the requirements for Alloy UNS No. C11000 (electrolytic tough pitch copper) or Alloy UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper) specified in ASTM B 152/B 152M.
- 3. Stainless Steel:
 - a. For the following items, provide stainless steel complying with the requirements for the type or grade specified for the item:
 - 1) Tubing:
 - a) Provide stainless steel tubing complying with the requirements for Grade MT 316L stainless steel specified in ASTM A 554.
 - 2) Castings:
 - a) Provide stainless steel castings complying with the requirements for Grade CF 8M or CF 3M stainless steel specified in ASTM A 743/A 743M.
 - 3) Sheet, Strip, Plate, and Flat Bar:
 - a) Provide stainless steel sheet, strip, plate, and flat bar complying with the requirements for Type 316L stainless steel specified in ASTM A 666.
 - 4) Bars and Shapes:
 - a) Provide stainless steel bars and shapes complying with the requirements for Type 316L stainless steel specified in ASTM A 276.
 - 5) Wire Rope and Wire-Rope Fittings:
 - a) Provide stainless steel wire rope complying with the requirements for 7-by-19 wire rope made from wire complying



with the requirements for Type 316 stainless steel specified in ASTM A 492.

- b) Provide wire rope connectors of the types indicated in the Contract Documents, fabricated from stainless steel, and having the capability to sustain, without failure, a load equal to the minimum breaking strength of the wire rope with which they are used.
 - c) Manufacturers:
 - (1) The Cable Connection, <http://www.thecableconnection.com>.
 - (2) Carl Stahl DecorCable, Inc., <http://www.decorable.com>.
 - (3) Esmet, Inc., <http://www.esmet.com>.
 - (4) Feeney Wire Rope & Rigging, <http://www.feeneygateway.com/feeneywire.html>.
 - (5) Hayn Enterprises, LLC, <http://www.hayn.com>.
 - (6) Johnson, C. Sherman, Co., Inc., <http://www.csjohnson.com>.
 - (7) Loos & Co., Inc.; Cableware Division, <http://www.loosco.com>.
 - (8) Ronstan International Inc., <http://www.ronstan.com>.
 - (9) Secosouth, Inc., <http://www.secosouth.com>.
 - (10) Approved equal.
4. Iron and Steel:
- a. For the following items, provide iron and steel complying with the requirements specified for the item:
 - 1) Bars:
 - a) Provide hot-rolled, carbon steel bars complying with the requirements for Grade 1010 bars specified in ASTM A 29/A 29M.
 - 2) Plates, Shapes, and Bars:
 - a) Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - 3) Cast Iron:
 - a) Unless otherwise indicated in the Contract Documents, provide either gray iron complying with the requirements specified in ASTM A 48/A 48M, or malleable iron, complying with the requirements specified in ASTM A 47/A 47M.
 - 4) Steel Sheet:
 - a) Provide cold rolled steel sheet complying with the requirements for either commercial steel or structural steel, exposed, specified in ASTM A 1008/A 1008M.
5. Fasteners:
- a. Fastener Materials:



- 1) Unless otherwise indicated in the Contract Documents, provide fasteners for the following items fabricated from the materials specified:
 - a) Aluminum Items:
 - (1) For aluminum items, provide fasteners fabricated from stainless-steel.
 - b) Copper-Alloy Items:
 - (1) For copper-alloy items, provide fasteners fabricated from silicon bronze.
 - c) Stainless-Steel Items:
 - (1) For stainless steel items, provide fasteners fabricated from stainless-steel.
 - d) Steel Items:
 - (1) For steel items, provide plated steel fasteners having plating that complies with the requirements for the Class Fe/Zn 25 electrodeposited zinc coating specified in ASTM B 633 unless otherwise indicated in the Contract Documents.
 - e) Dissimilar Metals:
 - (1) For dissimilar metals, provide fasteners fabricated from stainless-steel.
- b. Exposed Fasteners:
 - 1) For exposed fasteners, provide tamper-resistant flat-head machine screws unless otherwise indicated in the Contract Documents.
- c. Post-Installed Anchors:
 - 1) Provide torque-controlled expansion type anchors or chemical type anchors.
 - 2) For interior locations, provide zinc plated carbon-steel components that have been plated with zinc in accordance with the requirements for Class Fe/Zn 5 specified in ASTM B 633 or ASTM F 1941 (ASTM F 1941M), unless otherwise indicated in the Contract Documents.
 - 3) For exterior locations and where stainless steel is indicated in the Contract Documents, provide stainless-steel bolts complying with the requirements for Alloy Group 1 (A1) specified in ASTM F 593 (ASTM F 783M), and provide stainless-steel nuts, complying with the requirements specified in ASTM F 594 (ASTM F 836M).

E. Product Types:

1. Ornamental Metal Grilles:

- a. Where indicated on the Contract Drawings, provide ornamental metal grilles fabricated from the materials specified herein.
- b. Fabricate ornamental grilles from perforated stainless-steel sheet or plate having the thickness, size, and pattern indicated on the Contract Drawings.



- 1) The Contract Drawings indicate the perforated metal patterns required based on products of one manufacturer.
- 2) Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by Program/Project Manager.
- c. Manufacturers:
 - 1) Architectural Grille; Division of Giumenta Corporation, <http://www.archgrille.com>.
 - 2) Beaux-Artes, <http://www.beaux-artistes.com>.
 - 3) Harrington & King Perforating Company, Inc., <http://www.hkperf.com>.
 - 4) Reggio Register Company, Inc., <http://www.reggioregister.com>.
 - 5) Register & Grille Mfg. Co., Inc.
 - 6) Approved equal.
2. Ornamental Metal Clad Doors and Frames:
 - a. Where indicated on the Contract Drawings, provide ornamental metal clad doors and frames fabricated from the materials specified herein.
 - b. Laminate 0.0375 inch (0.95mm) thick stainless-steel sheets to the outside face of the hollow-metal doors and frames at the locations and in accordance with the details indicated on the Contract Drawings.
 - c. Provide the adhesive recommended by the metal fabricator that will fully bond metal to metal, and that will prevent telegraphing and oil canning.
 - d. Manufacturers:
 - 1) Dawson Metal Co., Inc., <http://www.dawsonmetal.com>.
 - 2) InKan Limited, <http://www.inkan.on.ca>.
 - 3) Krieger Specialty Products Company, <http://www.kriegerproducts.com>.
 - 4) Approved equal.
3. Combination Hall Push-Button Stations:
 - a. Provide combination hall push-button stations fabricated from stainless steel in accordance with the details indicated on the Contract Drawings.
 - b. Coordinate combination hall push-button stations with the requirements for the electric traction elevators to provide integrated, closely fitted assemblies.
 - 1) Fabricate faceplates from 1/8 inch (3.2mm) thick sheet having edges beveled at a 45-degree angle for one-half the thickness of metal.
 - 2) Provide combination hall push-button stations having a rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4 inch (100mm) wall depth.
 - 3) Provide combination hall push-button stations having emergency pictorial signs and text complying with requirements of the Authorities Having Jurisdiction, and indicating that in a fire



- emergency the elevators should not be used and that stairways should be used instead.
- a) Engrave the pictorial sign and text into the front surface of the faceplates to a depth of 1/16 inch (1.6 mm), and paint the engraving red.
 - 4) Provide cutouts in the faceplates for the push buttons of the elevator hall push-button station, card reader, and elevator key switches.
4. Exterior Façade Panels:
- a. Architectural Mesh Type I:
 - 1) Provide a woven stainless steel fabric system as shown on the Contract Drawings.
 - a) This is a performance specification.
 - b) The system specified has been carefully chosen due to its inherent performance characteristics.
 - c) A manufacturer is named to establish a reference for quality and appearance.
 - d) Lesser quality materials will not be considered or approved.
 - 2) Provide square architectural mesh panels in accordance with the approved Shop Drawings.
 - 3) Mesh:
 - a) Provide rigid stainless steel architectural mesh having open area over 64 percent of the surface, and weighing 2.03 pounds per square foot.
 - 4) Attachment System:
 - a) Provide a Type 316L stainless steel frame upon which the metal fabric is tack welded, and that has mitered corners that are welded and ground smooth for a polished finish.
 - b) Fabricate a compatible attachment system that satisfies the structural and performance requirements.
 - 5) Manufacturers:
 - a) Cambridge Architectural, Plait Mesh with the Angle Frame attachment system, www.cambridgearchitectural.com.
 - b) Approved equal.
 - b. Architectural Mesh Type II:
 - 1) Mesh:
 - a) Provide flexible Type 304L stainless steel architectural mesh having open area over 54 percent of the surface, and weighing 1.70 pounds per square foot.
 - b) Width:
 - (1) Provide an architectural mesh system no more than 240 inches wide.
 - c) Finish:
 - (1) Provide an architectural mesh system having a bright finish.



- 2) Attachment System:
 - a) Provide a Type 304L stainless steel tension system having custom cut apertures that receives the metal fabric ends in tubing that is integrated into a bracket and structural support design.
- 3) Manufacturers:
 - a) Cambridge Architectural, Stripe Mesh with the Eclipse attachment system, www.cambridgearchitectural.com.
 - b) Approved equal.
5. Ornamental Sheet Metal:
 - a. Provide ornamental sheet metal items complying with the requirements specified in Section 05580, Formed Metal Fabrications.

F. Fabrication:

1. Shop Fabrication:
 - a. Form decorative metal to the required shapes and sizes, true to line and level with true curves and accurate angles and surfaces.
 - 1) Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
 - b. Mill joints to a tight, hairline fit.
 - 1) Cope or miter corner joints.
 - 2) Fabricate connections that will be exposed to the weather so water will be excluded.
 - c. Comply with the recommended practices for in shop welding and brazing specified in the American Welding Society (AWS) reference standards.
 - 1) Weld and braze behind finished surfaces without distorting or discoloring the exposed side.
 - a) Clean exposed welded and brazed joints of flux, and dress the exposed and contact surfaces.
 - 2) Where welding and brazing cannot be concealed behind finished surfaces, finish the joints in accordance with the requirements for Type 1 Welds (no evidence of a welded joint) specified in NAAMM/NOMMA 500.
 - d. Provide castings that are sound and free of warp, cracks, blowholes, and other defects that impair strength or appearance.
 - 1) Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

G. Finishes:

1. Primer Materials:
 - a. Etching Cleaner:
 - 1) For galvanized metal, provide etching cleaner complying with the requirements specified in MPI# 25.
 - b. Galvanizing Repair Paint:



- 1) For galvanizing repairs, provide high-zinc-dust-content paint complying with the requirements specified in SSPC-Paint 20, and that is compatible with the paints specified to be used over it.
- c. Lacquer:
 - 1) For copper alloys, provide clear, acrylic lacquer specially developed for coating copper-alloy products.
- d. Shop Primers:
 - 1) Provide shop primers that comply with the requirements specified in Section 09912, Painting, and Section 09960, High-Performance Coatings.
 - 2) Universal Shop Primer for Ferrous Metal:
 - a) For ferrous metal, provide fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with the requirements specified in MPI# 79, and that is compatible with the topcoat.
 - 3) Epoxy Zinc-Rich Primer:
 - a) Provide epoxy zinc-rich primer complying with the requirements specified in MPI# 20, and that is compatible with the topcoat.
 - 4) Shop Primer for Galvanized Steel:
 - a) For galvanized steel, provide [water-based galvanized metal shop primer complying with the requirements specified in MPI# 134.
- e. Bituminous Paint:
 - 1) Provide cold-applied asphalt emulsion complying with the requirements specified in ASTM D 1187.
2. Finish Materials:
 - a. Aluminum:
 - 1) Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in DAF-45.
 - 2) Clear Anodic Finish:
 - a) Provide clear anodic finishes complying with the requirements for a AA-M12C22A41, Class I, 0.018mm or thicker finish specified in AAMA 611.
 - 3) Color Anodic Finish:
 - a) Provide color anodic finishes complying with the requirements for a AA-M12C22A42/A44, Class I, 0.018mm or thicker finish specified in AAMA 611, and having a champagne color.
 - 4) Baked-Enamel or Powder-Coat Finish:
 - a) Provide baked-enamel or powder-coat finishes complying with the requirements specified in AAMA 2603, except having a minimum dry film thickness of 1.5 mils (0.04mm).



- (1) Comply with the coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking the finish.
 - b) Color and Gloss:
 - (1) Provide color and gloss as selected by the Program/Project Manager from the manufacturer's full range.
- 5) Siliconized Polyester Finish:
 - a) Provide siliconized polyester finishes consisting of an epoxy primer and a silicone-modified, polyester-enamel topcoat having dry film thicknesses of not less than 0.2 mil (0.005mm) for the primer and not less than 0.8 mil (0.02mm) for the topcoat.
 - b) Color and Gloss:
 - (1) Provide color and gloss as selected by the Program/Project Manager from the manufacturer's full range.
- 6) High-Performance Organic Finish:
 - a) Provide high-performance organic finishes complying with the requirements for a two-coat fluoropolymer finish specified in AAMA 2605, and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in the color coat.
 - (1) Prepare, pretreat, and apply the coating to exposed metal surfaces in accordance with the coating and resin manufacturers' written instructions.
 - b) Color and Gloss:
 - (1) Provide color and gloss as selected by the Program/Project Manager from the manufacturer's full range.
- 7) High-Performance Organic Finish:
 - a) Provide high-performance organic finishes complying with the requirements for a three-coat fluoropolymer finish specified in AAMA 2605, and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both the color coat and the clear topcoat.
 - (1) Prepare, pretreat, and apply the coating to exposed metal surfaces in accordance with the coating and resin manufacturers' written instructions.
 - b) Color and Gloss:
 - (1) Provide color and gloss as selected by the Program/Project Manager from the manufacturer's full range.
- b. Copper-Alloy Finishes:



- 1) Finish designations prefixed by M conform to the system established by the National Association of Architectural Metal Manufacturers (NAAMM) and the National Ornamental and Miscellaneous Metals Association (NOMMA) for designating copper-alloy finish systems in NAAMM/NOMMA 500.
- 2) Buffed Finish:
 - a) Provide an M21 (smooth specular) finish.
- 3) Hand-Rubbed Finish:
 - a) Provide an M31-M34 (directionally textured, hand rubbed) finish.
- 4) Medium-Satin Finish:
 - a) Provide an M32 (directionally textured, medium satin) finish.
- 5) Fine-Matte Finish:
 - a) Provide an M42 (non-directional finish, fine matte) finish.
- 6) Buffed Finish, Lacquered:
 - a) Provide an M21-O6x (smooth specular; coating as specified) finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- 7) Hand-Rubbed Finish, Lacquered:
 - a) Provide an M31-M34-O6x (directionally textured, hand rubbed; coating as specified) finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- 8) Medium-Satin Finish, Lacquered:
 - a) Provide an M32-O6x (directionally textured, medium satin; coating as specified) finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- 9) Fine-Matte Finish, Lacquered:
 - a) Provide an M42-O6x (non-directional finish, fine matte; coating as specified) finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- 10) Statuary Conversion Coating over Satin Finish:
 - a) Provide an M31-C55 (directionally textured, fine satin; conversion coating, sulfide), having the color matching the Program/Project Manager's Sample finish.
- 11) Patina Conversion Coating:



- a) Provide an M36-C12-C52 (directionally textured, uniform; conversion coating, ammonium sulfate), having the color matching the Program/Project Manager's Sample finish.
- 12) Statuary Conversion Coating, Bright Relieved and Lacquered:
 - a) Provide an M12-C55-M2x-O6x (matte finish, as cast; conversion coating, sulfide; buffed; coating as specified), having the color matching the Program/Project Manager's Sample finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- 13) Blackened, Bright Relieved, and Lacquered:
 - a) Provide an M33-O60-M2x-O6x (directionally textured, coarse satin; black, air drying coating; buffed; coating as specified), having blackening and buffing matching the Program/Project Manager's Sample finish.
 - b) Coating:
 - (1) Provide a clear, organic lacquer designated for use on copper alloys.
- c. Stainless-Steel Finishes:
 - 1) Bright, Cold-Rolled, Unpolished Finish:
 - a) Provide a No. 2B finish.
 - 2) Directional Satin Finish:
 - a) Provide a No. 4 finish.
 - 3) Dull Satin Finish:
 - a) Provide a No. 6 finish.
 - 4) Reflective, Directional Polish:
 - a) Provide a No. 7 finish.
 - 5) Mirror-Like Reflective, Non-Directional Polish:
 - a) Provide a No. 8 finish.
- d. Steel and Iron Finishes:
 - 1) Galvanizing:
 - a) Hot-dip galvanize the products fabricated from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips and that are indicated to be galvanized in the Contract Documents in accordance with the requirements specified in ASTM A 123/A 123M.
 - b) Hot-dip galvanize steel and iron hardware indicated to be galvanized in the Contract Documents in accordance with the requirements specified in ASTM A 153/A 153M.
 - 2) Powder-Coat Finish:
 - a) For ferrous metal indicated to get a powder-coat finish in the Contract Documents, prepare, treat, and coat the metal in accordance with the resin manufacturer's written instructions and as follows:



- (1) Prepare the uncoated ferrous-metal surfaces in accordance with the requirements specified in SSPC-SP 6/NACE No. 3.
 - (2) Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
 - (3) Treat the prepared metal with a metallic-phosphate pretreatment, then rinse and seal the surfaces.
 - (4) Apply the thermosetting polyester or acrylic urethane powder coating so that the cured-film thickness is not less than 1.5 mils (0.04mm).
 - b) Color:
 - (1) Provide the color as selected by the Program/Project Manager from the manufacturer's full range.
3. Shop Finishing Methods:
 - a. Follow the recommendations for applying and designating finishes furnished in NAAMM/NOMMA 500.
 - b. Iron and Steel:
 - 1) Preparing Galvanized Items for Shop Priming:
 - a) After galvanizing, thoroughly clean the ornamental metal of grease, dirt, oil, flux, and other foreign matter; and treat the ornamental metal with etching cleaner.
 - 2) Preparing Non-galvanized Items for Shop Priming:
 - a) Prepare uncoated ferrous-metal surfaces in accordance with the requirements specified in SSPC-SP 6/NACE No. 3.
 - 3) Primer Application:
 - a) Unless otherwise indicated in the Contract Documents, apply shop primer to the prepared surfaces of the items.
 - (1) The primer does not have to be applied to surfaces that will be embedded in concrete or masonry.
 - b) Shop prime uncoated ferrous-metal surfaces with the primers specified in Section 09912, Painting and Section 09960, High-Performance Coatings unless zinc-rich primer is indicated.
 - c) Do not apply primer to galvanized surfaces.

2.02 ACCESSORIES

A. Welding Rods and Bare Electrodes:

1. Provide welding rods and bare electrodes selected in accordance with the requirements specified in the American Welding Society (AWS) welding specifications for the metal alloy welded.
2. For aluminum, provide welding rods and bare electrodes of the type and alloy recommended by the producer of the metal to be welded as required to produce a color match, the strength, and the compatibility required in the fabricated items.

B. Brazing Rods:



1. For copper alloys, provide brazing rods of the type and alloy recommended by the producer of the metal to be welded as required to produce a color match, the strength, and the compatibility required in the fabricated items.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify the dimensions, tolerances, and method of attachment with the other Work onsite.
- B. Evaluation and Assessment:
 1. Do not begin to install ornamental metal until the openings and substrates have been properly prepared to receive the products provided under this Section.
 2. If the substrate preparation is the responsibility of another installer, notify the Program/Project Manager of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the ornamental metal.
- B. Surface Preparation:
 1. Clean substrate surfaces thoroughly prior to installing the ornamental metal.
 2. Prepare the substrate surfaces using the methods recommended by the ornamental metal manufacturer for achieving the best result for the substrate under the Contract conditions.
- C. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Where needed to secure the ornamental metal to in-place construction, provide anchorage devices and fasteners acceptable to the ornamental metal manufacturer.
- B. Anchor supports securely in the location, and to the alignment and elevation, measured from established lines and levels with allowance for necessary thermal movement and structural support.



- C. Erect metalwork square, plumb, straight, and true.
 - 1. Do not install component parts that are observed to be defective, including warped, bowed, dented, abraded and broken members.
- D. Fit exposed connections accurately together to form tight, hairline joints; or, where indicated, uniform reveals and spaces for sealants and joint fillers.
- E. Do not cut or abrade finishes that cannot be completely restored in the field.
 - 1. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- F. Install concealed gaskets, joint fillers, insulation, and flashings as the ornamental metal Work progresses.
- G. Exterior Façade Panels:
 - 1. During installation of the exterior façade panels, furnish onsite engineering assistance by the Contractor's Professional Engineer.
 - 2. Install exterior façade panels in accordance with the exterior façade panel manufacturer's installation instructions.
 - a. Submit the exterior façade panel manufacturer's written installation instructions to the program/Project Manager for information.
 - 3. Separate dissimilar metals, and provide gasketed fasteners, isolation shims, or isolation tape where needed to eliminate the possibility of corrosive electrolytic action between metals.
- H. Special Techniques:
 - 1. Corrosion Protection:
 - a. Coat the concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.04 REPAIR/RESTORATION

- A. Touch-up, repair, or replace damaged products before Substantial Completion.

3.05 CLEANING

- A. Clean the exposed surfaces in accordance with the manufacturer's cleaning instructions.
 - 1. Unless otherwise indicated in the manufacturer's instructions, clean the metals by washing them thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
 - 2. Submit the manufacturer's written cleaning instructions to the Program/Project Manager for information



- B. Remove protective coverings from the ornamental metal only when there is no possibility of damage from other work.
 - 1. If the strippable film and other protective coverings have not been removed by the time of Substantial Completion, remove them then.
- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Restore protective coverings on the ornamental metal that have been damaged during shipment or installation.
- B. Protect installed ornamental metal products until the Work of the Contract is completed.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 05810

EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for expansion joint cover assemblies, including for the following applications:
 - a. Floor expansion joint cover assemblies.
 - b. Wall and ceiling expansion joint cover assemblies.
 - c. Exterior expansion joint seals.
 - d. Roof expansion joint assemblies.
 - e. Fire barrier systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 09961 - Fluoropolymer Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EIFS: An acronym for exterior insulation and finish systems.
 - 2. FRT: Fire or Flame Retardant Treated.
 - 3. PVC: Polyvinyl-chloride.
 - 4. UV: Ultraviolet.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. ASTM International (ASTM):
 - a. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - c. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.



- d. ASTM D 518 - Standard Test Method for Rubber Deterioration – Surface Cracking.
- e. ASTM D 2000 – Standard Classification System for Rubber Products in Automotive Applications.
- f. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- g. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.
- h. ASTM E 1399 - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
- i. ASTM E 1966 - Standard Test Method for Fire-Resistive Joint Systems.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 6. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 251 - Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
- 7. Underwriters Laboratories, Inc. (UL):
 - a. ANSI/UL 263 - Standard for Fire Tests of Building Construction and Materials.
 - b. ANSI/UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.
 - c. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.
 - d. [UL Qualification Tests and Follow-Up Service Requirements](#).
- 8. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
 - b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:



1. Coordinate the compatibility of the expansion joint cover assemblies specified in this Section with the expansion joint cover assemblies specified in other Sections.
 2. Coordinate blockout dimensions with the expansion joint manufacturer.
 3. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete, or to have recesses formed into edges of concrete slabs, for later placement and grouting-in of frames.
 - a. Provide the templates required to the related trade for locating support and anchorage items.
- B. Sequencing:
1. Sequence the Work of this Section with the work of related trades, particularly the installation of items embedded in concrete and masonry, so job progress is not delayed.
- C. Scheduling:
1. Coordinate the fabrication schedule for the expansion joint cover assemblies with actual construction progress to avoid delaying the Work.

1.04 SUBMITTALS

- A. Action Submittals:
1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Interior flush aluminum interior wall and ceiling seismic cover assemblies.
 - 2) Interior aluminum heavy duty seismic floor cover assemblies.
 - 3) Interior aluminum recessed pan interior seismic floor cover assemblies.
 - 4) Interior flush lightweight composite wall and ceiling seismic cover assemblies.
 - 5) Interior flush floor expansion joint covers.
 - 6) Exterior vertical exterior seals.
 - 7) Exterior vertical and horizontal exterior seals.
 - 8) Exterior pre-compressed sealant expansion joint covers.
 - 9) Metal roof covers.
 - 10) Split slab expansion joints.
 - 11) Fire barrier systems for floor or wall joints.
 - 12) Fire barrier systems for parking deck.
 - b. Shop Drawings:
 - 1) Fabrication and installation of the expansion joint cover assemblies.
 - 2) Template drawings.



- c. Samples:
 - 1) Samples of the expansion joint cover assemblies.
 - d. Certificates:
 - 1) Evidence of fire barrier systems Listing and Labeling.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Expansion joint cover assembly manufacturer's instructions and recommendations for preparing substrates.
 - 2) Expansion joint cover assembly manufacturer's installation instructions.
 - 3) Preformed seal manufacturer's recommendations and instructions for installing the preformed seal.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Certifications:
- 1. Fire Barrier Systems Certifications:
 - a. Provide fire barrier systems complying with the appropriate Underwriters Laboratory, Inc. Qualification Tests and Follow-Up Service Requirements.
 - b. Listing and Labeling:
 - 1) Provide fire barrier systems that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, Inc. for the location the product is installed in, and the application intended.
 - a) Provide products marked with their intended use or classification.
 - b) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - (1) Such evidence may consist of either a printed mark on the data or a separate listing card.
- C. Site Samples:
- 1. For initial selection purposes, submit Samples of the expansion joint cover assemblies in the form of the manufacturer's color charts, and actual units



or sections of units, showing the full range of colors, textures, and patterns available for each exposed metal and elastomeric material of the expansion joint cover assemblies indicated to the Program/Project Manager.

- a. Furnish Samples for each type of flexible seal to be used in the Work with color samples.
- b. Install elastomeric material for the joint's Samples to verify the color selected.
- c. Furnish Samples for each indicated type of metal finish on metal of the same thickness and alloy to be used in work.
 - 1) Where normal color and texture variations are to be expected, include 2 or more units in each set of Samples showing the limits of such variations.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials to the Site ready for use.
 2. Remove materials that are damaged or otherwise unsuitable for installation from the Site, and replace the unsuitable materials with acceptable materials at no increase in Contract Price.
- B. Storage and Handling Requirements:
 1. Store materials under cover in a dry and clean location off the ground.
 2. Exercise proper care when handling the materials so the finished surfaces are not damaged.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 EXPANSION JOINT COVER ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified and approval by the Program/Project Manager, products from other manufacturers may be provided.
 - b. Single-Source Responsibility:
 - 1) Obtain the expansion joint cover assemblies specified in this Section from one source and from a single manufacturer.



B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- 2) Provide materials and work conforming to all applicable codes and the requirements of the local Authorities Having Jurisdiction.

b. Americans with Disabilities Act (ADA):

- 1) Provide expansion joint systems complying with the requirements specified in the Americans with Disabilities Act (ADA) guidelines.

C. Performance:

1. Fire-Rated Joint Covers:

- a. At locations indicated on the Contract Drawings, provide expansion joint cover assemblies having the manufacturer's continuous, standard, flexible fire barrier seals under the covers to provide fire-resistive rating not less than the fire rating of the adjacent construction.
- b. Fire-Test-Response Characteristics:
 - 1) Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined by a Testing and Inspecting Agency acceptable to the Authorities Having Jurisdiction and in accordance with the requirements specified in ANSI/UL 263, NFPA 251, or ASTM E 119, including a hose stream test of vertical wall assemblies; and with the requirements specified in ANSI/UL 2079.
 - 2) Fire-Resistance Ratings:
 - a) Provide expansion joint cover assemblies having fire-resistance ratings as indicated in the Contract Documents, but not less than the rating of adjacent construction.

2. Allowable Loading Criteria:

a. Live Load:

- 1) Provide an expansion joint system capable of withstanding a distributed live load of 200 pounds per square foot.
- 2) Provide an expansion joint system capable of withstanding a single axle load of 1440 pounds applied by airport courtesy carriages.

b. Floor Cover Loading Characteristics:

- 1) Provide heavy-duty covers capable of withstanding a point load of 2,000 pounds.

3. Joint Movement:

- a. Provide an expansion joint system capable of withstanding movement of plus or minus 50 percent of the joint width without system



separations or failure, and without considerable change to the system's walking surface that might contribute to a trip hazard.

D. Design Criteria:

1. The expansion joint cover assemblies indicated in the Contract Drawings are based on expansion covers manufactured by Construction Specialties, Inc.
2. Provide expansion joint cover assemblies having the design, basic profile, materials, and operation indicated in the Contract Drawings.
 - a. Select units comparable to those indicated or required to accommodate the joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested in accordance with the requirements specified in ASTM E 1399.
 - 1) Provide an expansion joint system weighing a minimum of 6 pounds per lineal foot.
 - b. Engineer the aluminum floor plates and their supporting tubes so they are capable of supporting the loading from courtesy vehicles without cracking adjacent porcelain tiles.
 - 1) Provide supporting tubes that are a minimum of 6 inches apart on center and the aluminum plate that is at least 1/4 inch thick.
 - 2) Size tubes and lower plates to accept 3/8-inch porcelain tile and 1/4-inch thinset mortar flush with the top of the expansion joint.
 - c. Provide factory welded corners where joints change direction or abut other materials.
 - d. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections and other accessories as required to provide continuous joint cover assemblies.
 - 1) Nosing Trim:
 - a) Provide single exposed aluminum nosing trim not exceeding 3/4 inch in width, and that is easily replaceable.
 - e. For floor assemblies, provide expansion joint cover assemblies having their upper and lower aluminum components attached by threaded fasteners.
 - 1) Aluminum components that are *snap* together are unacceptable due to live load considerations.
3. Product Data:
 - a. Prepare Product Data for each type of expansion joint cover assembly and accessory specified.
 - 1) Indicate the movement capability of the cover assemblies, and the suitability of the material used in exterior seas for exposure to Ultraviolet (UV) radiation.
 - 2) Include the manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.



- b. Submit the Product Data to the Program/Project Manager for approval.
- 4. Shop Drawings:
 - a. Prepare Shop Drawings for the Work specified herein showing the full extent of the expansion joint cover assemblies.
 - 1) Show the fabrication and installation of the expansion joint cover assemblies, including plans, elevations, sections, details of components, joints, splices, and attachments to other units of Work.
 - a) Furnish large-scale details indicating the profiles of each type of expansion joint cover assembly, splice joints between sections, joinery with other types, special end conditions, the anchorage's, fasteners, and the relationship to adjoining work and finishes. Shop drawing details shall indicate standard flashing components and be a complete expansion joint cover assembly system to ensure that transitions are watertight.
 - b) Furnish a description of the materials and finishes, and installation instructions.
 - c) Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
 - d) Provide isometric drawings of intersections, terminations, and changes in joint direction or planes, depicting how components interconnect with each other and adjacent construction, specific to this project, to allow movement and achieve waterproof continuity.
 - 2) Template Drawings:
 - a) Furnish typical expansion joint cross-sections indicating pertinent dimensions, general construction, component connections, anchorage methods, and hardware locations.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- 5. Coordination: Coordinate installation of exterior and interior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight.

E. Materials:

- 1. Aluminum:
 - a. For extrusions, provide aluminum complying with the requirements for Alloy 6063-T5 specified in ASTM B 221.
 - 1) Provide aluminum extrusions in lengths of at least 10 feet.
 - b. For sheet and plate, provide aluminum complying with the requirements for Alloy 6061-T6 specified in ASTM B 209.
- 2. Exterior Seals:
 - a. Provide exterior seals consisting of 2 single layered flexible extrusions, one interior polyvinyl-chloride (PVC) extrusion and one



exterior non-hydroscopic thermoplastic rubber extrusion classified as indicated in ASTM D 2000, retained in a set of compatible frames.

- 1) Provide Santoprene™ 8000 series thermoplastic rubber manufactured by ExxonMobil Chemicals.
- b. Provide exterior seals of the color indicated in the Contract Drawings, or if not indicated, as selected by the Program/Project Manager from the manufacturer's standard colors.
3. Fire Barriers:
 - a. Provide fire barriers designed for the indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399 or ASTM E 1966.
 - b. Employ a nationally recognized Testing and Inspecting Agency acceptable to Authorities Having Jurisdiction to test the fire barriers in the maximum joint width condition with a field splice as a component of an expansion joint cover in accordance with the requirements specified in ANSI/UL 263, NFPA 251, or ASTM E 119, and ANSI/UL 2079, including the hose stream test of vertical wall assemblies for the full-rated period.
4. Leaf Springs:
 - a. Provide leaf springs fabricated from flexible tempered SAE stainless steel secured to an aluminum retainer by a snap-lock fit.
 - 1) Mechanical attachments, or rotation of the spring element, at this point are unacceptable.
 - b. Provide leaf springs in lengths of at least 10 feet.
5. Moisture Barrier:
 - a. Provide moisture barrier fabricated from flame retardant, extruded polyvinyl-chloride (PVC) complying with the requirements specified in ASTM D 412, and having a Durometer hardness of 60, plus 1, minus 5.
 - b. Supply moisture barrier in the longest continuous piece practical to keep the number of field splices to a minimum.
 - c. Provide Gutter profile moisture barrier fabricated from flexible fabric reinforced neoprene gutter that satisfies the required movement criteria and compresses without damage during the full cycle of joint closure. The moisture barrier shall have +/- 100% versatile movement capability, a minimum fabric type of 4 ounce polyester cloth, Hardness Shore A of 70 +/- 5, 1,000 psi tensile strength, and 250% elongation.
6. Hardware and Fasteners:
 - a. Provide zinc plated hardware and fasteners of the size and length indicated on the Contract Drawings.
 - b. Provide fasteners of a metal, type, and size suiting the type of construction indicated in the Contract Documents, and capable of securely attaching the expansion joint cover assemblies to the in-place construction.



- 1) For masonry and concrete where anchoring members are not embedded in concrete, provide drilled-in fasteners having threaded fasteners.
7. Anchors:
 - a. Provide anchors having a diameter of at least 3/8 inch.
- F. Product Types:
 1. Interior Seismic Joint Covers:
 - a. Flush Aluminum Interior Wall and Ceiling Seismic Cover Assemblies:
 - 1) Provide a continuous extruded aluminum frame assembly having a profile designed to accommodate a colorable thermoplastic seal having rigid edges designed for positive attachment to the aluminum frame.
 - a) Provide flexible core seals having a shore hardness of 73 and that allow a maximum movement of 1 inch without allowing gaps to occur between the seal and its cover assembly.
 - (1) Unless otherwise specified, provide thermoplastic seals having one of the manufacturer's standard colors.
 - b) Provide continuous aluminum frames designed to be surface mounted and spackled into drywall.
 - 2) Provide flush seismic cover assemblies free from grooves or ridges
 - 3) For wall seals, provide a flexible base closure where required.
 - 4) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Flexible Wall Seal: Model FWFC-M-400.
 - (2) Flexible Ceiling Seal: Seismic Series Model FCF-400.
 - b) Approved equal.
 - b. Aluminum Heavy Duty Seismic Floor Cover Assemblies:
 - 1) Provide a continuous extruded aluminum frame assembly having a profile designed to accommodate a free floating aluminum center plate as indicated in the Contract Drawings.
 - a) Protect aluminum surfaces in contact with concrete by applying a heavy metal free high solids primer.
 - b) Provide aluminum having a mill finish.
 - 2) To center and hold the center plate in place, provide stainless steel turn bar assemblies spaced no more than 24 inches apart on center.
 - 3) Heavy Duty Floor Cover:
 - a) On each side of the joint, provide a continuous heavy duty two-piece frame designed to support minimum 1/4-inch thick center plate capable of supporting a 2000-pound point load without damage or permanent deformation.
 - 4) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.



- (1) Heavy Duty Seismic Floor Cover Assemblies: Seismic Series Model SJ-500HD.
 - b) Approved equal.
- c. Aluminum Recessed Pan Interior Seismic Floor Cover Assemblies:
 - 1) Provide a continuous extruded aluminum frame assembly having a profile designed to accommodate a free floating center plate as indicated in the Contract Drawings.
 - a) Protect aluminum surfaces in contact with concrete by applying a heavy metal free high solids primer.
 - 2) Provide covers that allow thermal movement of plus or minus 1/2, inch, and horizontal movement during a seismic event of plus or minus 50 percent of the joint width.
 - 3) To center and hold the center palate in place, provide spring-loaded stainless steel turn bar assemblies spaced no more than 18 inches apart on center.
 - 4) To allow full seismic movement without damage to the cover, provide a concealed lifting device for the center plate.
 - a) Provide a cover designed to disengage under seismic conditions only.
 - 5) Concealed Stone Flush Floor Cover:
 - a) Provide a continuous frame on each side of the joint supporting a center pan designed to receive stone paver or concrete fill.
 - 6) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Heavy Duty Floor Cover: Seismic Series Model SSR-400.
 - b) Approved equal.
 - d. Flush Composite Wall and Ceiling Seismic Cover Assemblies:
 - 1) Provide a continuous extruded aluminum frame assembly having a profile designed to accommodate a free floating composite panel as indicated in the Contract Drawings.
 - 2) To hold the composite panels in place, provide a hook and loop attachments spaced no more than 18 inches apart on center, and a secondary support system comprised of pre-tensioned shock cords installed directly behind the panel and attached with removable "S" hooks.
 - 3) Flush Wall/Ceiling Cover:
 - a) Provide a continuous frame on each side of the joint supporting a lightweight composite panel cover, and designed to finish flush with the adjacent wall or ceiling surface.
 - b) Provide cover assemblies that allow movement up to 100 percent of the joint width.
 - c) Factory-prime and field paint the panel, or cover the panel with field-applied wall covering.
 - 4) Manufacturers:



- a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Flush Composite Wall/Ceiling Covers: Model LAF-400.
 - b) Approved equal.
- e. Flush Floor Expansion Joint Covers:
 - 1) Provide flush floor expansion joint covers capable of supporting a 2000-pound point load without damage or permanent deformation, and having a continuous heavy duty frame on each side of the joint that are designed to support a cover plate that is at least 1/4 inch thick, and that are centered throughout the movement cycle by stainless steel spring clips 18 inches apart on center.
 - 2) Finish:
 - a) Provide flush floor expansion joint covers having a mill finish.
 - 1) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Flush Floor Expansion Joint Covers: Model GFP-400.
 - b) Approved equal.
- 2. Exterior Expansion Joint Covers:
 - a. Vertical Exterior Seals:
 - 1) Provide extruded aluminum side frames that retain extruded Santoprene™ thermoplastic rubber primary seals, and complete with an independent and continuous polyvinyl-chloride (PVC) back seal.
 - a) Mount the side frames on butyl caulk tape using appropriate anchors spaced 18 inches apart on center.
 - b) Provide the primary seal with multi movement grooves designed to remain in place throughout movement of the joint up to 100 percent of the joint width.
 - (1) Provide thermoplastic seals having one of the manufacturer's standard colors or a custom color selected by the Program/Project Manager.
 - c) Ensure a watertight system by providing factory heat welded transitions where applicable.
 - 2) At the base of vertical joints, provide material for field-formed flexible base closures.
 - 3) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Vertical Exterior Seals: Model SF-400.
 - b) Approved equal.
 - b. Vertical and Horizontal Exterior Seals:
 - 1) For precast to precast; precast to exterior insulation and finish systems (EIFS); and EIFS to EIFS, vertical or horizontal as indicated; provide a beige extruded aluminum primary visual seal and a continuous extruded polyvinyl-chloride (PVC) secondary moisture seal.



- 2) Provide factory-fabricated 90-degree mitres and custom angles as required.
- 3) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Vertical and Horizontal Exterior Seals: Model SF-600, SF-700 or SF-800.
 - b) Approved equal.
- c. Pre-Compressed Sealant Expansion Joint Covers:
 - 1) For vertical applications where the attachment of metal frames is undesirable or impractical, provide pre-compressed sealant expansion joint covers consisting of open micro-cell polyurethane foam impregnated with a hydrophobic, polymer sealing compound, and having a factory-applied colored elastomeric silicon face to produce a watertight, dustproof, airtight, UV stable, chemically resistant, sound-proof, and insulated primary seal when measured in accordance with the requirements specified in ASTM D 518 and ASTM E 283.
 - 2) Provide a continuous silicon sealant bead that is at least 1/4 inch wide at the joint edges.
 - 3) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Connector Walkways Next to Existing Structures: Models VF-400, VF-600.
 - (2) Deflection Joints: Model VF-100, VF-200, VF-300, VF-400, VF-600, VF-800.
 - b) Emseal Joint Systems, Ltd, www.emseal.com.
 - (1) Vertical Exterior Joints: Colorseal
 - (2) Deck Joints: Horizontal Colorseal
 - (3) Seismic and High Movement Joints: Seismic Colorseal
 - c) Approved equal.
3. Roof Covers:
 - a. Metal Roof Covers:
 - 1) Provide continuous extruded aluminum base frame sections having a continuous extruded polyvinyl-chloride (PVC) sealing gasket, and seated on a continuous 1/16-inch thick neoprene or polyethylene vapor barrier.
 - a) Fasten the base frame sections to the roof curb at locations 24 inches apart on center.
 - b) To cover the adjacent edge of the roof membrane, incorporate an adjustable angle flange into the base frames that is designed to be folded onsite.
 - c) Hold roof to roof and roof to wall aluminum covers in place using stainless steel turn bar assemblies located 24 inches apart on center.



- 2) Provide an aluminum cover formed from aluminum sheet at least 0.078-inch thick and finished with a fluoropolymer coating, complying with the requirements specified in Section 09961, Fluoropolymer Coatings, matching the adjacent wall panels.
- 3) Flash and/or cap all ends.
 - a) To ensure maximum weather tightness, factory-fabricate transitions and end caps.
- 4) Seal butt joints with an aluminum splice cover bedded on caulk and fastened on one side only.
- 5) Manufacturers:
 - a) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - (1) Metal Roof to Wall Covers: Models SRJW-600 and SRJW-800.
 - (2) Roof to Roof (Floor to Floor) Covers: Model SRJ-1200 with a custom fire or flame retardant treated (FRT) wood blocking moisture barrier and a 16-inch wide neoprene vapor barrier.
 - (3) Roof to Wall Covers (at train column shafts): Model BRJW-600 having a secondary moisture seal.
 - b) Approved equal.
4. Heavy Duty Split Slab Expansion Joints:
 - a. Provide split slab expansion joints and covers consisting of continuous Santoprene® membrane seal elements having continuous metal wings tied into the membrane on each side of the joint, and that are mechanically attached to the floor structure on each side of the joint.
 - b. Provide stainless steel or aluminum capping for the wings.
 - c. Manufacturers:
 - 1) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - a) Guideway Seal Covers: Model PDA 400X9.
 - 2) Approved equal.
5. Fire Barrier Systems:
 - a. Unless otherwise detailed, provide prefabricated fire barrier assemblies complying with the requirements specified in ASTM E 1966, and certified to have a 2-hour rating when tested in accordance with ANSI/UL 2079.
 - b. For floor and wall expansion joints having nominal joint widths from 1 inch to 20 inches and requiring plus or minus 50 percent movement, in tension, compression and lateral shear, provide pre-engineered floor or wall fire barrier systems consisting of ceramic blankets, ceramic papers, stainless foil, and screens.
 - c. For parking deck expansion joints having nominal joint widths up to 14 inches, provide fire barrier systems consisting of intumescent blankets layered to provide a flame and insulation barrier, and to accommodate the specified dynamic movement.



- d. To minimize field splicing, provide components of the longest lengths practical.
 - e. Manufacturers:
 - 1) Construction Specialties, Inc. (C/S), www.c-sgroup.com.
 - a) Fire Barrier Systems for Floor or Wall Joints: Models MFX-4F, MFX-4W, and MFX-5F.
 - b) Fire Barrier Systems for Parking Decks: Model FB-97.
 - 2) Approved equal.
- G. Fabrication:
- 1. Fabricate expansion joint cover assemblies in sections and assemblies as large as practical.
 - a. Furnish units in the longest practicable lengths to minimize the number of end joints and minimize field splicing.
 - 2. Factory fabricate 90-degree mitres and custom angles as required.
 - a. Factory-weld or mechanically fasten mitred corners.
 - b. Mitre and weld floor gaskets with a color to match the gasket color.
 - 3. Except in component pieces to receive the threaded end of self-tapping fasteners, pre-drill anchoring and assembly holes in the factory.
- H. Finishes:
- 1. Metal Finishes
 - a. Except as otherwise indicated in the Contract Documents, comply with the requirements regarding finish designations and application recommendations specified in NAAMM AMP 500.
 - 1) Apply finishes in the factory after the products are fabricated.
 - 2) Protect finishes on exposed surfaces with protective covering before shipment.
 - b. Aluminum Finishes
 - 1) Finish designations prefixed by AA refer to finishes defined by the system for designating aluminum finishes established by the Aluminum Association and specified in AA DAF-45.
 - 2) Protect aluminum surfaces in contact with cementitious materials by applying a heavy metal free high solids primer or a chromate conversion coating.
 - 3) Mill Finish:
 - a) Where a mill finish is specified, provide an AA-M10 (unspecified mill finish) finish.
 - 4) Clear Anodize Finish, Class II:
 - a) Where a Class II Clear Anodize Finish is specified, provide an AA-C22A31 finish having a medium matte etched finish with at least a 0.4-mil thick anodic coating.
 - 5) Paint Finish:
 - a) Paint aluminum roof covers.
 - b) Where a paint finish is specified, apply an inhibited thermocured primer having at least a 0.02-mil dry film



thickness, and a thermocured fluorocarbon coating containing fully 70 percent Kynar 500 resin and having at least a 1.0-mil dry film thickness.

- c) Provide the color indicated in the Contract Documents, or if none is indicated, provide a color selected by the Program/Project Manager from manufacturer's standard colors.
- 6) Factory Primed Concealed Surfaces:
 - a) Protect concealed metal surfaces that will be in contact with concrete and masonry surfaces when installed by applying a shop coat of the manufacturer's standard primer to contact surfaces.
 - b) Provide a primer dry film thickness of at least 2.0 mils.
- 2. Composite Panel Finishes:
 - a. Finish composite panels in the field by applying a prime coat and 2 finish coats of a commercially available acrylic latex system.

2.02 ACCESSORIES

- A. Provide the manufacturer's standard anchors, fasteners, set screws, spacers, flexible vapor seals and filler materials, drain tubes, adhesives, and other accessories compatible with material in contact required for complete installations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify all measurements and dimensions at the Site.
 - a. Make a thorough examination of all surfaces receiving the Work of this Section.
 - b. Before fabricating the expansion joint cover assemblies, check the actual locations of walls and other construction to which the Work of this Section must fit by accurate field measurements where necessary.
 - c. Show the measurements recorded on the final Shop Drawings.
- B. Evaluation and Assessment:
 - 1. Before starting to install expansion joint cover assemblies, notify the Program/Project Manager in writing of any defect which would affect the satisfactory completion of the Work of this Section.

3.02 PREPARATION

- A. Protection of In-Place Conditions:



1. Protect adjacent areas from damage resulting from installation of the expansion joint cover assemblies.
- B. Surface Preparation:
 1. Comply with the manufacturer's instructions and recommendations for preparing substrates.
 - a. Submit the manufacturer's instructions and recommendations for preparing substrates to the Program/Project Manager for information.
 2. Provide anchorage devices and fasteners where necessary for securing expansion joint cover assemblies to in-place construction.
 - a. Unless otherwise specified, space anchors and assembly hardware a maximum of 18 inches apart on center.
 3. Prior to installation of the expansion joints, float concrete floor slabs and expansion joint blockouts with a cementitious leveling compound as required to properly install the expansion joint cover assemblies.
- C. Demolition / Removal:
 1. Perform the cutting, drilling and fitting required to install expansion joint covers in accordance with the requirements specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Comply with the expansion joint cover assembly manufacturer's instructions and recommendations for installing and applying materials.
 1. Securely attach expansion joint cover assemblies in place with all required accessories.
 2. Submit the expansion joint cover assembly manufacturer's installation instructions to the Program/Project Manager for information.
- B. Anchorages:
 1. Locate anchors at the interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches on center.
 2. Mechanically fasten expansion joint lengths using countersunk bolts and concealed aluminum plates.
- C. Install joint cover assemblies in true alignment and in proper relationship to the expansion joints and adjoining finished surfaces measured from established lines and levels.
 1. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling.
 - a. Cut and fit the ends of frames to produce joints that will accommodate the thermal expansion and contraction of the metal.
 2. Set floor covers flush with adjacent finished floor materials.



- a. If necessary, shim floor covers to level them, but ensure that base frames have continual support to prevent rocking and vertical deflection.
 3. Locate wall, ceiling, roof and soffit covers so they are in continuous contact with adjacent surfaces.
 4. Align metal members mechanically using splice joints.
 5. Maintain the continuity of the expansion joint cover assemblies, and keep end joints to a minimum.
- D. Preformed Seals:
 1. Adhere flexible filler materials, if any, to the frames using adhesive or pressure-sensitive tape as recommended by manufacturer.
 2. Prior to installing the preformed seal, apply the manufacturer's approved adhesive, epoxy, or lubricant-adhesive to both frame interfaces.
 3. Install extruded preformed seals in accordance with the manufacturer's instructions, and so they have the minimum number of end joints possible.
 4. For straight sections provide preformed seals in continuous lengths.
 5. To provide watertight joints, vulcanize or heat-seal field splice joints made in the preformed seal material using the manufacturer's recommended procedure.
 6. Seal transitions in accordance with the manufacturer's instructions.
 7. Submit the preformed seal manufacturer's recommendations and instructions for installing the preformed seal to the Program/Project Manager for information.
- E. Exterior Seal Joint Assemblies
 1. Install exterior flexible seals using standard lengths.
 2. Install secondary seals using continuous lengths.
 - a. To provide watertight joints in secondary seal material, vulcanize field splice joints using the manufacturer's recommended procedures.
 3. To provide a watertight installation, seal the end joints within continuous runs of exterior seal joint assemblies, and joints at transitions, in accordance with the manufacturer's directions.
 4. Seal transitions and butt joints in accordance with the manufacturer's instructions.
- F. Fire Barriers:
 1. Install fire barriers, including transitions and end joints in strict accord with the manufacturer's installation instructions so fire-rated construction is continuous.
 - a. Install fire barrier in accordance with Federal, State, and local building codes using the manufacturer's recommended procedures.



3.04 CLEANING

- A. When protective material is removed from the expansion joint cover assemblies, clean the exposed metal surfaces in accordance with the manufacturer's instructions.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Do not remove protective coverings until finish work in the adjacent areas is complete.
- B. Take proper precautions to protect the Work of this Section from damage after it is installed in place.
 - 1. Comply with manufacturer's instructions and recommendations for protection of installed units.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 05830

BRIDGE EXPANSION JOINT ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing the following types of bridge expansion joint assemblies for elevated guideway as detailed on the Contract Drawings at the locations indicated thereon.
 - a. Cellular compression expansion seals.
 - b. Strip expansion seals.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. IRM: Industry reference materials.
 - 2. MR: Movement Rating.
 - 3. pphm: Parts per hundred million.
- B. Reference Standards:
 - 1. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Drawings – Construction Standards.
 - 1) ADOT Standard Drawing SD 3.01 (B-24.20 replacement).
 - 2. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - e. ASTM D 395 - Standard Test Methods for Rubber Property—Compression Set.
 - f. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.
 - g. ASTM D 471 - Standard Test Method for Rubber Property—Effect of Liquids.
 - h. ASTM D 518 - Standard Test Method for Rubber Deterioration—Surface Cracking.



- i. ASTM D 573 - Standard Test Method for Rubber—Deterioration in an Air Oven.
- j. ASTM D 1149 - Standard Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber.
- k. ASTM D 2240 - Standard Test Method for Rubber Property—Durometer Hardness.
- l. ASTM D 3542 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Bridges.
- m. ASTM D 4070 - Standard Specification for Adhesive Lubricant for Installation of Preformed Elastomeric Bridge Compression Seals in Concrete Structures.
- n. ASTM F 1135 - Standard Specification for Cadmium or Zinc Chromate Organic Corrosion Protective Coating for Fasteners.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-SP 6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing and inspections performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- 2. 10 days before the bridge expansion joint assemblies are to be installed, give notice to those performing other construction work related to the bridge expansion joint assembly installation, such as to those performing work that will provide support of the bridge expansion joint assemblies, to allow such items to be introduced or furnished before the deck joint assemblies are installed.

B. Sequencing:

- 1. Install bridge expansion joint assemblies in the blockouts constructed in the deck slabs as shown on the Contract Drawings.

1.04 SUBMITTALS

A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Bridge expansion joint assemblies.
 - b. Certificates:
 - 1) Bridge Expansion Joint Certificates of Compliance.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's recommendations for installing cellular compression expansion joints.
 - b. Site Quality Control Submittals:
 - 1) Elastomer seals from bridge expansion joint assemblies for testing.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Special Inspections:
 - a. No Work in this Section is subject to Special Inspections per the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ independent Testing and Inspection Agencies, including the City Building Official and the City of Phoenix Testing Laboratory.
- B. Certifications:
 1. Bridge Expansion Joint Certificates of Compliance:
 - a. Prior to providing bridge expansion joint assemblies, submit a Certificate of Compliance for each material or manufactured assembly to the Program/Project Manager for approval.
 - b. Include the following information in each Certificate of Compliance:
 - 1) A description of the material supplied.
 - 2) The quantity of material represented by the Certificate of Compliance.
 - 3) The means of identifying the material, such as a label, lot number, or other marking.



- 4) A statement certifying that the material complies in all respects with the requirements specified, such as reference standards, tables, or Specification Sections.
- 5) The name, title, signature, and date of the signature of a person having legal authority to bind the manufacturer or Supplier of the material or manufactured assembly.
- c. Do not have the person having the legal authority sign the Certificate of Compliance sign it before all other required information has been inserted on the Certificate.
 - 1) Do not alter, add to, or change in any way a Certificate of Compliance after the authorized signature has been affixed to the original Certificate, except notations of a clarifying nature, such as the Project number, which do not affect the basic requirements of the Certificate.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure that materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - a. Deliver the bridge expansion joint assembly components to be embedded in or attached to concrete in ample time so that the Work is not delayed.
2. Cellular Compression Expansion Seals:
 - a. Deliver each lot of lubricant adhesive and sealant for cellular compression expansion seals in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture.
 - 1) On the shipping containers, indicate special precautions and instructions required due to product toxicity or flammability, and other similar information pertinent to the proper storage and use of the product.
 - b. Ship deck joint assemblies of cellular compression expansion seals fully assembled, and equipped with shipping and temperature adjustment devices approved by the Program/Project Manager.
3. Strip Expansion Joints:
 - a. Deliver strip seal gland to the Site in lengths suitable for continuous one-piece installation of each individual expansion joint.

B. Storage and Handling Requirements:

1. Handle the bridge expansion joint assembly components so no parts are bent, broken, or otherwise damaged; and avoid damage to other material and work.
 - a. Exercise care to avoid over stressing the units.
 - b. Replace pieces that are damaged, unless the Program/Project Manager authorizes repairs.



2. Store the bridge expansion joint assembly components on platforms, skids, or other supports to prevent contact with dirt, debris, and moisture.
 - a. Protect the bridge expansion joint assembly components from exposure to conditions that produce rust.

PART 2 PRODUCTS

2.01 ASSEMBLIES

A. Description:

1. Provide bridge expansion joint assemblies consisting of elastomer and metal assemblies anchored to the concrete at the joint.
 - a. Armor:
 - 1) For cast-in place seal assemblies, provide steel armor.

B. Performance:

1. Provide bridge expansion joint assemblies that satisfactorily resist the intrusion of foreign material and water.
2. Cellular Compression Expansion Joints:
 - a. Provide expansion joint seals having a Movement Rating (MR) of not less than the Movement Rating indicated on the Contract Drawings.
 - 1) Provide seals capable of being compressed to 40 percent of the original width without damage while at the same time maintaining the center of the top of the exposed surface of the seal below the top surface of the installed joint.
 - b. Provide expansion joint seals that maintain their top and bottom edges in continuous contact with the side of the armor over the entire joint movement range.

C. Design Criteria:

1. Provide bridge expansion joint assemblies compatible with concrete.
2. Provide bridge expansion joint assemblies resistant to abrasion, oxidation, aging, and sunlight.
3. Provide bridge expansion joint assemblies resistant to oils, gasoline, salt, and other materials that may be spilled on or applied to the surface.
4. Cellular Compression Expansion Joints:
 - a. Provide cellular compression expansion joint seals having a minimum depth, measured at the contact surface, of at least 95 percent of the uncompressed width of the seal as indicated by the manufacturer.
5. Shop Drawings:
 - a. Prepare Shop Drawings of the bridge expansion joint assemblies showing, at a minimum, complete details of the installation method to be followed a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature, and additions or rearrangements of the reinforcing steel from that shown on the Contract Drawings.



- b. Submit the bridge expansion joint assemblies Shop Drawings to the Program/Project manager for approval.

D. Materials:

1. Cellular Compression Expansion Joints:

- a. Provide cellular compression expansion joints consisting of prefabricated preformed elastomer joint seal material complying with the requirements specified in ASTM D 3542.

- 1) Extrude compression seals from multi-channels to produce nonporous, homogeneous material in its finished form.

- b. Lubricant Adhesive and Sealant:

- 1) Provide lubricant adhesive and sealant complying with the requirements specified in ASTM D 4070 for the cellular compression expansion joint seals.

- 2) Provide lubricant adhesive and sealant having a viscosity so the material remains fluid from 5 degrees Fahrenheit to 120 degrees Fahrenheit, and suitable for use with the installation equipment furnished.

2. Strip Expansion Joints:

- a. Provide strip expansion joint seals consisting of preformed, non-reinforced, elastomer strip seal glands that mechanically lock into steel retainers.

- 1) Provide strip seal glands fabricated from polychloroprene elastomer complying with the requirements specified in ASTM D 3542, except modified as follows:
 - a) Exclude recovery testing requirements.
 - b) Comply with the requirements specified in Table 05830-1 instead of the requirements specified in Table 1 of ASTM D 3542.

Table 05830-1 Preformed Elastomer Strip Seal Physical Properties		
Property	Requirement	Test Method
Tensile strength, minimum	2000 psi	ASTM D 412
Elongation at break, minimum	250 percent	ASTM D 412
Hardness, Type A durometer	60±5 points	ASTM D 2240 (modified) ^{(1),(3)}
Oven aging, 70 hours at 212 degrees Fahrenheit		
Tensile strength, maximum loss	20 percent	ASTM D 573
Elongation, maximum loss	20 percent	ASTM D 573



Table 05830-1 Preformed Elastomer Strip Seal Physical Properties		
Property	Requirement	Test Method
Hardness, Type A durometer	0 to +10 points change	ASTM D 2240 (modified) ^{(1),(3)}
Oil swell, IRM 903 for 70 hours at 212 degrees Fahrenheit, maximum weight change	45 percent	ASTM D 471
Ozone resistance, 20 percent strain, 300 pphm in air, 70 hours at 104 degrees Fahrenheit	No cracks	ASTM D 1149 (modified) ⁽²⁾
Low temperature stiffening, 7 days at 14 degrees Fahrenheit, hardness, Type A durometer	0 to +15 points change	ASTM D 2240 (modified) ^{(1),(3)}
Compression set, maximum, 70 hours at 212 degrees Fahrenheit	40 percent	ASTM D 395 Method B (modified) ⁽¹⁾
1. The term modified in the table relates to specimen preparation. The use of the strip seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification must be agreed to by both Contractor and Supplier before testing. 2. Test in accordance with Procedure A of ASTM D 518, and express ozone concentration in pphm. 3. Perform the hardness test with the durometer in a durometer stand as recommended in ASTM D 2240.		

- b. To install the strip seal gland into the locking steel retainer, provide adhesive lubricant consisting of a one part moisture curing polyurethane compound complying with the requirements specified in ASTM D 4070.
 3. Structural Shapes and Plates:
 - a. Provide steel shapes and plates complying with the requirements specified in ASTM A 36/A 36M.
- E. Fabrication:
 1. Shop Fabrication:
 - a. Shop-fabricate strip expansion joint seal miters, tees, and crosses in a mold under heat and pressure.
- F. Shop Finishing Methods:
 1. Strip Seal Assemblies:
 - a. Galvanize the metal parts of the strip seal assemblies after fabrication in accordance with the requirements specified in ASTM A 123/A 123M and ASTM A 153/A 153M.



2. Cellular Compression Expansion Seal Assemblies:
 - a. The metal parts of cellular compression expansion seals are not required to be galvanized, plated, or painted.

2.02 ACCESSORIES

- A. Fasteners:
 1. Provide high strength bolts complying with the requirements specified in ASTM A 325, and having a protective coating of cadmium or zinc followed by a chromate ad baked organic coating in accordance with the requirements for Grade 3, 5, 6, 7, or 8 and Color Code A specified in ASTM F 1135.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify the joint opening is adequate to allow easy installation of the cellular compression expansion joint seal element.
- B. Evaluation and Assessment:
 1. If a joint opening is inadequate to allow easy installation of the required seal element, shop-install the cellular compression expansion joint into deck joint assemblies.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Cover or otherwise protect the joints to be sealed prior to installing the elastomer portion of the assembly.
- B. Surface Preparation:
 1. Provide anchorage devices and fasteners where necessary for securing bridge expansion joint assemblies to in-place construction.

3.03 INSTALLATION

- A. Provide bridge expansion joint assemblies of the type and at the locations indicated on the Contract Drawings.
 1. Install the elastomer portion of each assembly when and in a way so it will not be damaged by subsequent construction operations.
 2. Install the bridge expansion joint assemblies at the narrowest joint opening possible to allow for long term creep.
 3. Form the joint with a secondary concrete pour.



- a. Prior to placing the concrete, coat the surface of the existing concrete with an approved adhesive specifically formulated for bonding new concrete to old concrete.
 4. Immediately prior to installing the seal element, ensure that the metal contact surfaces of the joint armor are clean, dry, and free of oil, rust, paint, and foreign material.
- B. Cellular Compression Expansion Joint Installation:
 1. Install cellular compression expansion joints in accordance with the manufacturer's recommendations using equipment specifically manufactured for that purpose.
 - a. Furnish equipment to install the cellular compression expansion joints that will not structurally damage either the seal element or the joint armor; and that will not twist, distort, or otherwise cause malformations in the installed seal element.
 - b. Submit the manufacturer's recommendations for installing cellular compression expansion joints to the Program/Project Manager for information.
 2. Unless otherwise indicated on the Contract Drawings or ADOT Standard Drawing SD 3.01 (B-24.20 replacement), provide cellular compression expansion joint seals the full length of the bridge expansion joint.
 3. Immediately prior to applying lubricant adhesive and sealant, clean the contact surfaces of the seal element using normal butylacetate and clean rags or mops.
 4. Apply lubricant adhesive and sealant to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer.
 - a. If fully assembled deck joint assemblies are provided, provide units having the lubricant adhesive shop-applied to both the seal and the armor contact surfaces; and install these assemblies as a unit.
 5. At the open ends of cellular compression expansion joint seals that could admit water or debris, fill each cell with commercial quality open cell polyurethane foam to a depth of 3 inches, or close the ends by another means approved by the Program/Project Manager.
- C. Strip Expansion Joint Installation:
 1. Anchor the strip expansion joint steel retainers provided into the structure in accordance with the requirements indicated in the Contract Documents.
 2. Do not install strip seal glands at joint openings less than 1-1/2 inches wide.
 3. Provide a continuous one-piece strip seal gland for each individual expansion joint.
 - a. Prior to installing the strip seal gland, clean the steel surfaces coming into contact with the strip seal gland in accordance with the requirements of SSPC-SP 6.
 - b. Field splicing the strip seal gland is unacceptable.



D. Tolerances:

1. Cast-In-Place Concrete Tolerances:

- a. The maximum allowable tolerances or deviations from the dimensions shown on the Contract Drawings or approved Shop Drawings are as follow:
 - 1) Deviation in alignment of the bridge expansion joint assembly from a straight line parallel to the centerline is 1/8 inch in each 10 feet of length.
 - 2) Deviation in bearing seat flatness from a plane surface is plus or minus 1/8 inch in each 10 feet of length.
 - 3) Deviation in overall depth and in the thickness of slabs is plus 1/4 inch, minus 1/8 inch.
 - 4) Variation in cross-sectional dimensions is plus 1/4 inch, minus 1/8 inch.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

- 1. During the period when bridge expansion joint assemblies are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other inspection and testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- 2. Tests:
 - a. Bridge Expansion Joint Material Testing:
 - 1) Test Procedure:
 - a) Provide one piece of each bridge expansion joint material at least 18 inches longer than otherwise required by the Contract Drawings.
 - (1) Remove this excess material and submit it to the Program/Project Manager for testing by the Testing and Inspection Agency.
 - 2) Acceptance Criteria:



- a) Bridge expansion joint material complying with the specified requirements will be acceptable.
 - b. Concrete Compressive Strength Test:
 - 1) Test Procedure:
 - a) Sampling and testing of the compressive strength of the cast-in-place concrete will be performed in accordance with the procedures specified in Section 03300, Cast-In-Place Concrete.
 - 2) Acceptance Criteria:
 - a) Cast-in-place concrete complying with the specified requirements will be acceptable.
 - 3. Inspections:
 - a. The installed seal elements are subject to approval of the Program/Project Manager.
 - b. Perforations and/or tears of the seal element due to installation procedures or construction activities are cause for rejecting the installed element.
- B. Non-Conforming Work
- 1. Promptly remove and replace Work that does not comply with specified requirements.
 - a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.

3.05 PROTECTION

- A. Protect deck joint assemblies in place until the adjacent blockouts are back-poured with concrete.
- B. Do not allow vehicular traffic on cast-in-place structures until at least 10 days after the last concrete has been placed in each continuous portion of the structure, and until the compressive strength has reached the specified 28-day compressive strength.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 05835

ELASTOMERIC BEARING PADS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for furnishing and installing elastomeric bearing pads as indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCE STANDARDS:

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M 251 - Standard Specification for Plain and Laminated Elastomeric Bridge Bearings.
 - 2. AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 4th Edition with 2008 U.S. Edition Interim.
- B. ASTM International (ASTM):
 - 1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength-Low Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 3. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 4. ASTM D 395 - Standard Test Methods for Rubber Property – Compression Set.
 - 5. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
 - 6. ASTM D 518 - Standard Test Method for Rubber Deterioration-Surface Cracking.
 - 7. ASTM D 573 - Standard Test Method for Rubber-Deterioration in an Air Oven.
 - 8. ASTM D 1149, Standard Test Method for Rubber Deterioration –Surface Ozone Cracking in a Chamber.
 - 9. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.
 - 10. ASTM D 4014 - Standard Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges.



- C. State of Arizona:
 - 1. Arizona Department of Transportation (ADOT):
 - a. ADOT Standard Specifications for Road and Bridge Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

1.04 SYSTEM DESCRIPTION

- A. Provide steel-reinforced bearing pads for supporting structural elements consisting of alternating elastomer laminates and internal steel laminates, bonded together, and having top and bottom elastomer covers.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Steel reinforced laminated bearing pad.
 - b. Samples:
 - 1) Steel reinforced laminated bearing pad.

1.06 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
- B. Site Samples:
 - 1. Submit 2 Samples of the steel reinforced laminated bearing pads to be used on the elevated guideway to become test specimens.

**PART 2 PRODUCTS****2.01 MATERIALS:****A. Elastomeric Compound/Elastomer:**

1. As the raw elastomer, provide virgin crystallization-resistant polychloroprene (neoprene) that exhibits physical properties in Table 05835-1:

Table 05835-1 Elastomeric Compound/Elastomer Properties		
Physical Property	Test Method	Requirement
Hardness	ASTM D 2240	60+/-5
Tensile Strength (Minimum)	ASTM D 412	15.5 MPa
Ultimate Elongation (Minimum)	ASTM D 412	350 %
Heat Resistance: 70 hours at 100 deg C		
Change in durometer hardness (Maximum)	ASTM D 573	+15%
Change in tensile strength	ASTM D 573	-15%
Change in ultimate elongation (Maximum)	ASTM D 573	-40%
Compression Set: 22 hours at 100 deg C	ASTM D 395, Method B	35%
Ozone Cracking	ASTM D 518; ASTM D 1149 ⁽¹⁾	No cracks
1. ASTM D 518: Method A, 20 percent strain, 100 hours; ASTM D 1149:100 pphm ozone in air by volume, 37.7 degree C \pm 1 degree C.		

B. Internal Reinforcement:

1. Provide steel conforming to the following requirements for internal reinforcement of the elastomer:
 - a. 3/16 Inch (4.7625mm) Thick and Thicker: Provide steel plate conforming with the requirements specified in ASTM A 36/A 36M.
 - b. Under 3/16 Inch (4.7625mm) Thick: Provide steel sheet conforming with the requirements for Grade 36 or 40 as specified in ASTM A 1011/A 1011M, or conforming with the requirements for Grade C or D as specified in ASTM A 1008/A 1008M.

C. Adhesive:



1. For attaching the bearing pad to concrete and steel bearing surfaces at locations indicated on the Contract Drawings, provide solvent-free epoxy adhesive suitable for the purpose and appropriate for the particular installation as approved by the Program Manager.

D. Fabrication:

1. Shop Fabrication:
 - a. Fabricate laminated steel bearing pads in conformance to the applicable requirements of ASTM D 4014 or AASHTO M 251.
 - 1) Bearing pads less than 1/2 inch in thickness may be either laminated or fabricated completely out of elastomer; bearing pads thicker than 1/2 inch must be laminated.
 - 2) Mold laminated pads as a single unit under pressure and heat.
 - a) Provide reinforcement parallel to the top and bottom surfaces of the pad.
 - b) Bond the elastomer to laminates and to external load plates during molding.
 - 3) At the outer edges of bonds, shape the elastomer to conform to the external load plates to avoid stress concentrations.
 - 4) Provide internal steel laminates free of sharp edges.
 - 5) Do not stack individual laminated pads to attain thicknesses over 1/2 inch.
2. Fabrication Tolerances:
 - a. Fabricate elastomeric bearing pads within the tolerances specified in ASTM D 4014.

2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program Manager.
 - a. Notify the Program Manager when manufacturing, fabrication, or mill testing of the items intended for the Work of this Section are to be performed.
2. The Testing and Inspection Agency or the City of Phoenix Testing Laboratory will perform the source testing specified in this Paragraph.
3. Elastomeric Bearing Pad Tests:
 - a. Test Procedure:
 - 1) The tests specified in Subsection 1013-3 of the ADOT Standard Specifications for Road and Bridge Construction, will be performed on samples of the elastomeric bearing pads.
 - b. Acceptance Criteria:
 - 1) Elastomeric bearing pads complying with the criteria specified in Subsection 1013-3 of the ADOT Standard Specifications for Road



and Bridge Construction, which references AASHTO M 251, are acceptable.

4. Inspections:

- a. Perform visual inspections in accordance with the requirements specified in Subsection 1013-3 of the ADOT Standard Specifications for Road and Bridge Construction.

B. Non-Conforming Work:

1. Bearings having dimensions or properties outside the tolerances specified will be rejected.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install elastomeric bearing pads in accordance with the details indicated on the Contract Drawings and with the requirements specified in Section 1013 of the ADOT Standard Specifications for Road and Bridge Construction.
- B. Interface with Other Work:
 1. Ensure that bearing surfaces comply with the requirements specified in Section 1013 of the ADOT Standard Specifications for Road and Bridge Construction.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/1/2017	N/A	All	First edition.





SECTION 06105

MISCELLANEOUS CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for miscellaneous carpentry, including the following:
 - a. Wood blocking and nailers.
 - b. Plywood backing panels.
 - c. Non-combustible substrates (wood substitute material).
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - a. Requirements for complying with the ENVISION Sustainable Infrastructure Rating System under this Contract are specified in Section 01360, Sustainable Design Requirements.
- B. Definitions:
 - 1. Dressed “S4S”: Dressed (surfaced) on all four sides.
 - 2. No. 1 Grade or Construction Lumber: Wood having moderate sized knots; paints well.
 - 3. No. 2 Grade or Standard Lumber: Wood having larger sized and more numerous knots; paints fairly well.
 - 4. Dimension lumber: Wood of thicknesses 2 inches up to, but not including, 5 inches.



C. Reference Standards:

1. American Society of Mechanical Engineers Standards (ASME):
 - a. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
 - b. ASME B18.6.1 - Wood Screws (Inch Series).
2. American Wood Protection Association (AWPA):
 - a. AWPA T1 – Use Category System: Processing and Treatment Standard.
 - b. AWPA U1 – Use Category System: User Specification for Treated Wood.
 - c. AWPA M4 - Standard for the Care of Preservative-Treated Wood Products.
3. ASTM International (ASTM):
 - a. ASTM A 153/A 153M - - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - c. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - d. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - e. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - f. ASTM C 954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - g. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - h. ASTM D 5516 - Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.
 - i. ASTM D 5664 - Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
 - j. ASTM E 136 - 04 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
 - k. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - l. ASTM F 1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.



5. Forrest Stewardship Council (FSC):
 - a. FSC-STD-01-001 - FSC Principles and Criteria for Forest Stewardship.
6. ICC Evaluation Services, Inc.
 - a. ICC ES 94-61.01 – ES Legacy Report: Viroc Type T2 Cement Bonded Particleboard.
7. National Lumber Grades Authority (NLGA):
 - a. NGLA Standard Grading Rules For Canadian Lumber.
8. Northeastern Lumber Manufacturers Association (NeLMA):
 - a. NeLMA Standard Grading Rules for Northeastern Lumber, <http://www.nelma.org/Page-10.html>.
9. Southern Pine Inspection Bureau (SPIB):
 - a. SPIB Standard Grading Rules for Southern Pine Lumber.
10. United States Government:
 - a. Department of Commerce:
 - 1) Product Standards:
 - a) PS-1-07 – Structural Plywood Standard.
 - b) PS-20-05 – American Softwood Lumber Standard.
11. Institute for Sustainable Infrastructure (ISI):
12. a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.
13. West Coast Lumber Inspection Bureau (WCLIB):
 - a. WCLIB Standard Number 17 - Grading Rules for West Coast Lumber.
14. Western Wood Products Association (WWPA):
 - a. WWPA G5 - Western Lumber Grading Rules '05.

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Wood structural panels.
 - 2) Non-combustible substrate and non-combustible sheathing.
 - 3) Non-combustible nailers.
 - 4) Wood preservative treatment.
 - 5) Fire retardant treatment.
 - b. Certificates:
 - 1) Fire-Retardant Treated Material Certification.
 - 2) Wood-Preservative Treated Material Certification

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Source Quality Control Submittals:
 - 1) Information showing compliance of preservative treated wood with the Phoenix Building Construction Code.
 - 2) Information showing compliance of fire retardant treated wood with the Phoenix Building Construction Code.
 - b. Manufacturer's Instructions:
 - 1) Wood preservative treatment chemical manufacturer's written instructions for handling, storage, installing and finishing treated materials.
 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit 4AR1.3 – Recycled Content
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Certified Wood
 - 1) Submit Chain of Custody (COC) certificates indicating that new wood provided complies with Forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product. If product is a mix of recycled content and new wood, provide breakdown by weight of each component and material values for each separately.
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content.
 - d. Composite Wood & Agrifiber Products
 - 1) Submit product data stating that product contains No Added Urea Formaldehyde (NAUF).
- C. Closeout Submittals:
1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Manufacturers warranties for each type of fire-retardant and wood preservative treatment.



1.04 QUALITY ASSURANCE

- A. Regulatory Agency Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - b. Submit information to the Program/Project Manager to show compliance of the following with the Phoenix Building Construction Code:
 - 1) Preservative treated wood.
 - 2) Fire retardant treated wood.
- B. Certifications:
 - 1. Fire-Retardant Treated Material Certification:
 - a. Submit certification provided by the treating plant to the Program/Project Manager certifying that the fire retardant treated materials comply with the specified requirements.
 - 1) Include the physical properties of the treated materials, both before and after exposure to the elevated temperatures experienced when the materials are tested in accordance with the requirements specified in ASTM D 5516 and ASTM D 5664.
 - 2. Wood-Preservative Treated Material Certification:
 - a. Submit certification provided by the treating plant to the Program/Project Manager certifying that the preservative treated materials comply with the specified requirements.
 - 1) Indicate the type of preservative used, and the net amount of preservative retained.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 - 1. Stack lumber, plywood, and other panels.
 - a. Provide for air circulation around stacks and under coverings.
 - 2. Create space between each bundle of lumber to provide air circulation.

1.06 WARRANTY

- A. Manufacturer Warranty:
 - 1. Provide warranties from the chemical treatment manufacturers for each type of fire-retardant and wood preservative treatment.
 - 2. Submit the warranties to the Program/Project Manager for information.



PART 2 PRODUCTS

2.01 SUSTAINABILITY REQUIREMENTS:

- A. Sustainability Requirements:
 - 1. FSC Certification
 - a. Provide wood materials that are procured through an FSC chain of custody from sustainably managed forests.
 - 2. No Added Urea Formaldehyde (NAUF)
 - a. Provide products that manufactured with NAUF.

2.02 DESIGN CRITERIA:

- A. Provide miscellaneous lumber for the support or attachment of other construction, including blocking, cants, nailers, furring, and grounds.
 - 1. For dimension lumber size, provide Construction, Stud, or No. 2 grade lumber having maximum moisture content of 19 percent.
 - 2. For concealed bards provide lumber having maximum moisture content of 19 percent and consisting of any of following species or grades:
 - a. Mixed Southern Pine:
 - 1) Provide No. 2 grade mixed southern pine lumber, graded in accordance with the SPIB Standard Grading Rules for Southern Pine Lumber.
 - b. Hem-fir or Hem-fir (North):
 - 1) Provide Construction or No. 2 Common grade hem-fir or hem-fir (north) lumber, graded in accordance with the NGLA Standard Grading Rules For Canadian Lumber, WCLIB Standard Number 17 - Grading Rules for West Coast Lumber, or WWPA G5.
 - c. Spruce-Pine-Fir (south) or Spruce-Pine-Fir:
 - 1) Provide Construction or No. 2 Common grade spruce-pine-fir (south) or spruce-pine-fir lumber; graded in accordance with the rules of NeLMA Standard Grading Rules for Northeastern Lumber, NGLA Standard Grading Rules For Canadian Lumber, WCLIB Standard Number 17 - Grading Rules for West Coast Lumber, or WWPA G5.
 - d. Eastern Softwoods:
 - 1) Provide No. 2 Common Grade eastern softwood lumber; graded in accordance with the NeLMA Standard Grading Rules for Northeastern Lumber.
 - e. Northern Species:



- 1) Provide No. 2 Common grade northern species lumber; graded in accordance with the NGLA Standard Grading Rules For Canadian Lumber.
 - f. Western Woods:
 - 1) Provide Construction or No. 2 Common grade western woods lumber; graded in accordance with the rules of WCLIB Standard Number 17 - Grading Rules for West Coast Lumber or WWP A G5.
 3. Submit Product Data for each type of factory-fabricated product to the Program/Project Manager for approval.
 - a. Indicate the processes used to fabricate the products.
 - b. Indicate component materials and dimensions.
 - c. Include construction and application details.
- B. Fire-Retardant Treated Materials:
1. Treat all wood provided for miscellaneous carpentry with fire-retardant in accordance with the performance requirements specified in AWWPA T1 and AWWPA U1.
 - a. Only provide fire-retardant treatment for which the manufacturer publishes physical properties for the lumber after it has been treated and exposed to elevated temperatures.
 - 1) The physical properties must be determined by a qualified independent Testing and Inspection Agency according to the requirements specified in ASTM D 5664 for lumber and in ASTM D 5516 for plywood.
 - b. Provide fire-retardant treatment that is non-corrosive to metal fasteners.
 2. Identify the material with an appropriate classification marking of Underwriters Laboratories, Inc; U.S. Testing; Timber Products Inspection; or another Testing and Inspecting Agency acceptable to the Authorities Having Jurisdiction.
 3. Unless otherwise indicated, provide interior Type A, high temperature (HT) rated material.
 - a. Provide exterior type material for exterior locations and other locations indicated in the Contract Documents.
 4. Submit Product Data for the fire retardant treatment from the chemical treatment manufacturer to the Program/Project Manager for approval.
- C. Wood-Preservative Treated Materials:
1. Treat the following items with wood preservative:
 - a. Wood cants, nailers, curbs, equipment support bases, blocking and similar members provided in connection with roofing, flashing, vapor barriers, and water proofing.



- b. Wood sills, sleepers, blocking furring, stripping and similar concealed members that will be in contact with concrete or masonry.
2. Submit Product Data for the wood preservative treatment from the chemical treatment manufacturer to the Program/Project Manager for approval.
3. Submit the wood preservative treatment chemical manufacturer's written instructions for handling, storage, installing and finishing treated materials to the Program/Project Manager for information.

2.03 MATERIALS

A. Lumber:

1. Provide lumber that has been factory-marked with the grade stamp of the grading agency on each piece of lumber.
2. Where nominal sizes are indicated, provide the actual sizes required by PS-20-05 for the moisture content specified.
 - a. Where actual sizes are indicated in the Contract Documents, they are minimum dressed sizes for dry lumber.
3. Unless otherwise indicated, provide dressed lumber, S4S.
4. For dry lumber having a nominal thickness of 2 inches or less, provide lumber having maximum moisture content of 19 percent at the time of dressing unless otherwise indicated.

B. Wood Structural Panels:

1. Provide wood structural panels factory-marked to indicate the applicable standard on each panel.
2. Provide plywood complying with the requirements specified in PS-1-07.
3. Provide wood structural panels of the thickness needed to comply with requirements specified, but not less than the thickness indicated in the Contract Documents.

C. Wood-Preservative Treated Materials:

1. Provide materials treated by the pressure process in accordance with the requirements specified in AWPA T1 and AWPA U1.
2. Provide material that is kiln-dried after treatment to have a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - a. Do not provide warped material or material that does not comply with the requirements for untreated material.
3. Provide materials marked with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.



- D. Non-Combustible Substrate (Wood Substitute):
1. Non-Combustible Substrate and Non-Combustible Sheathing:
 - a. Provide non-combustible nailing substrate consisting of Portland cement bonded particle board.
 - b. Basis of Design:
 - 1) The Basis of Design is "Viroc", which is available from Allied Building Products Corp., www.virocusa.com.
 - a) An ICC Evaluation Services Legacy Report for Viroc, ICC ES 94-61.01, is available indicating approval of Viroc by BOCA as Type T2 cement bonding particle board.
 - 2) The Basis of Design is intended to establish a standard of quality for achieving the desired architectural effect.
 - a) Do not construe The Basis of Design as limiting competition.
 2. Non-Combustible Nailer and Non-Combustible Sheathing:
 - a. Provide non-combustible nailer and non-combustible sheathing conforming to the following requirements:
 - 1) Impact Resistance:
 - a) Provide materials having impact resistance complying with the requirements specified in ASTM D 256.
 - 2) Fire Resistance:
 - a) Provide non-combustible materials having fire-resistance complying with the requirements specified in ASTM E 136.

2.04 ACCESSORIES

- A. Fasteners:
1. Provide fasteners of the size and type indicated and complying with the material and manufacturing requirements specified.
 2. Where carpentry will be exposed to the weather, be in contact with the ground, or in an area of high relative humidity, provide fasteners coated with hot-dip zinc complying with the requirements specified in ASTM A 153/A 153M, or fabricated from Type 304 stainless steel.
 3. Nails, Wire, Bards, and Staples:
 - a. Provide nails, wire, bards, and staples complying with the requirements specified in ASTM F 1667.
 4. Wood Screws:
 - a. Provide wood screws meeting the requirements of ASME B18.6.1.
 - b. For fastening to cold-formed metal framing, provide screws complying with the requirements specified in ASTM C 954, except provide wafer heads and reamer wings.
 - 1) Provide lengths as recommended by the screw manufacturer for the material being fastened.



5. Lag Bolts:
 - a. Provide lag bolts complying with the requirements specified in ASME B18.2.1.
 6. Bolts, Nuts, and Washers:
 - a. Bolts:
 - 1) Provide steel bolts complying with the requirements for Grade A bolts as specified in ASTM A 307.
 - b. Nuts and Washers:
 - 1) Provide steel hex nuts complying with the requirements specified in ASTM A 563; and, where indicated, flat washers.
 7. Anchors:
 - a. Provide expansion anchors fabricated from carbon-steel components, zinc plated complying with the requirements for Class Fe/Zn 5 coatings as specified in ASTM B 633.
 - b. Provide anchor bolt and sleeve assemblies capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies; and load equal to equal to 4 times the load imposed when installed in concrete, as determined when tested in accordance with the requirements specified in ASTM E 488 by a qualified independent testing and inspection agency.
- B. Metal Framing Anchors:
1. Galvanized Steel Framing Anchors:
 - a. Provide galvanized steel framing anchors having the structural capacity, of the type and size indicated in the Contract Documents, and that are acceptable to Authorities Having Jurisdiction.
 2. Galvanized Sheet Steel:
 - a. Provide hot-dip, zinc-coated steel sheet complying with the requirements for a G60 coating designation as specified in ASTM A 653/A 653M.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set carpentry to the required levels and lines, with members plumb, true to line, cut, and fitted.
 1. Fit carpentry to other construction.
 2. Scribe and cope carpentry as needed for an accurate fit.



- B. Locate nailers, blocking, and similar supports so they comply with the requirements for attaching other construction.
- C. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.
- D. Fastening:
 - 1. Use fasteners of the appropriate type and length.
 - 2. Pre-drill members when necessary to avoid splitting wood.
 - 3. Unless otherwise indicated in the Construction Documents, recess bolts and nuts flush with the surfaces.
 - a. Countersink fastener heads on exposed carpentry work, and fill holes with wood filler.
- E. Wood Blocking and Nailer Installation:
 - 1. Install wood blocking and nailers where indicated and where required for attaching other work.
 - 2. Form wood blocking and nailers to the shapes indicated, and cut them as required for the true line and level of the attached work.
 - 3. Attach items to substrates to support the applied loading.
- F. Special Techniques:
 - 1. Apply field treatments complying with AWP A M4 to cut surfaces or preservative-treated lumber and plywood.
- G. Interface with Other Work:
 - 1. Coordinate the locations of miscellaneous carpentry with the other work involved.

3.02 SITE QUALITY CONTROL

- A. Non-Conforming Work:
 - 1. Discard material with defects that would impair the quality of carpentry, and that are too small to use with a minimum number of joints or optimum joint arrangement.

3.03 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.B, 1.02.B	Add requirements for ENVISION Sustainability Rating System



SECTION 06605

FIBERGLASS REINFORCED PLASTIC WALL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for fiberglass reinforced plastic wall panels.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01770 - Closeout Procedures.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. FRP: Fiberglass reinforced plastic.
 - 3. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties.
 - 4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
 - b. ASTM D 570 – Standard Test Method for Water Absorption of Plastics



- c. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics
- d. ASTM D 696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
- e. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- f. ASTM D 953 – Standard Test Method for Bearing Strength of Plastics
- g. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule #1168 – Adhesive and Sealant Applications.
- 4. Institute for Sustainability Infrastructure (ISI)
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the Work of this Section with the work of other trades which passes through the wall covering.
- B. Sequencing:
 - 1. Where applicable, install paneling before installation of plumbing, casings, bases, cabinets, and other items to be applied over paneling.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Panels and accessories.
 - 2) Moldings at panel edges.
 - 3) Adhesive.
 - 4) Sealant.
 - 5) Corner and trim moldings.
 - 6) Miscellaneous items.
 - b. Shop Drawings:
 - 1) Joints and fastener attachments.



- c. Samples:
 - 1) Color and texture samples.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Sustainable Design Submittals:
 - 1) Low-Emitting Materials: Adhesives & Sealants, Submittal for adhesives and sealants used with fiberglass reinforced plastic (FRP) panels.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Cleaning and maintenance instructions.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Sustainability Standards Certifications:
 - 1. Adhesives and Sealants Submittal:
 - a. For the sealants and sealant primers used within the fiberglass reinforced plastic wall panels, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, certifying that these products comply with SCAQMD Rule #1168.
- C. Site Samples:
 - 1. Submit specified color and texture sample of the wall panels and trim pieces for verification.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver materials clearly labeled to identify the manufacturer, brand name, quality or grade, and the fire hazard classification.



B. Storage and Handling Requirements:

1. Store wall panels horizontally in the original undamaged packages.
2. Remove foreign matter from the face of the panels with a soft bristle brush, avoiding abrasive action.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Install materials when the temperature and humidity conditions approximate conditions that will exist when the building is occupied.
2. Provide ventilation to disperse fumes during application of the adhesive as recommended by the adhesive manufacturer.

1.08 MANUFACTURER WARRANTY

- A. Provide the manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer List:

1. Marlite, Marlite Standard FRP, www.marlite.com.
2. Kemlite Company, Glasbord-P with SurfaSeal, www.kemlite.com.
3. Approved equal.

B. Substitution Limitations:

1. Provide panels and accessories by one manufacturer to ensure the warranty and color match.

2.02 SUSTAINABILITY REQUIREMENTS

- A. Provide adhesives and sealants for use within the fiberglass reinforced plastic wall panels that are capable of qualifying the Project for Sustainability Credit.

2.03 DESIGN CRITERIA

A. Product Data:

1. Submit manufacturer's Product Data and installation instructions for each proposed material and accessory to the Program/Project Manager for approval.

B. Shop Drawings:



1. Submit Shop Drawings showing the locations and dimensions of proposed joints and fastener attachments to the Program/Project Manager for approval.

2.04 MATERIALS

A. Panels and Accessories:

1. Fiberglass Reinforced Plastic (FRP):
 - a. Provide 0.09-inch thick fiberglass reinforced plastic meeting or exceeding the requirements specified in Table 06605-1.

Table 06605-1 Fiberglass Reinforced Plastic Properties		
Property	Test Method	Acceptable Value
Bearing Strength	ASTM D 953	20,000 psi
Flexural Strength	ASTM D 790	17,000 psi
Flexural Modulus	ASTM D 790	0.85 x 10 ⁶ psi
Tensile Strength	ASTM D 638	8000 psi
Coefficient of Lineal Thermal Expansion	ASTM D 696	20 x 10 ⁻⁶ in/in°F
Water Absorption	ASTM D 570	< 0.5 %
*Thermal Conductivity (K-factor)	ASTM C 177	1.2 BTU/in/hr/ft ² /°F
Flamespread	ASTM E 84	- < 200*
Smoke Developed	ASTM E 84	- < 450*

B. Moldings at Panel Edges:

1. Provide 2-piece batten type moldings at the panel edges with snap-on trim.
2. Color/Texture:
 - a. Provide a white panel with an embossed texture.

C. Adhesive:

1. Provide the manufacturer's recommended type adhesive for use with the selected materials.
2. Provide waterproof, mildew resistant non-staining type adhesive.
3. VOC Limit for Adhesive: 70 gallons per Liter less water.



- D. Sealant:
 - 1. Provide latex type sealant as approved by the adhesive and wall paneling manufacturer.
 - 2. VOC Limit for Sealant: 250 gallons per Liter less water.
- E. Corner and Trim Moldings:
 - 1. Provide extruded anodized aluminum trim pieces.
 - 2. Provide moldings at internal and external corners.
- F. Miscellaneous Items:
 - 1. Provide supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation, whether or not specified or otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the substrate and conditions under which the material is to be installed.
 - 2. Verify that surfaces, when tested with a moisture meter, have the proper moisture content.
 - 3. Verify that nails and screws are recessed, with joints and depressions taped, finished, and sealed.
- B. Evaluation and Assessment:
 - 1. Do not proceed with the Work of this Section until the work of other trades which passes through the wall covering has been completed, and unsatisfactory conditions have been corrected.
 - 2. Starting the Work indicates acceptance of responsibility for performance and any required remedial Work.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Remove plumbing escutcheons, switchplates, wall plates, and surface-mounted fixtures, and cut wall paneling evenly to fit.
 - a. Replace items after completion of Work.
 - 2. Remove contaminants from areas to be covered.



3.03 INSTALLATION

- A. Install panels in accordance with the manufacturer's printed instructions using the full sheet mastic coverage method with no exposed fasteners or "buttons".
- B. Make joints with a 1/8 inch space for expansion, and use moldings designed for each condition for the Contract.
- C. Bevel the edges of panels with a block plane to permit proper fit into moldings.
- D. If one end of a panel must be nailed, do not nail the other end.

3.04 CLEANING

- A. Remove excess adhesive and smudges with a soft cloth and mineral spirits, or with a product recommended by the wall panel manufacturer.
 - 1. Submit cleaning and maintenance instructions in accordance with Section 01770, Closeout Procedures.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition
1	12/20/2017	N/A	1.02.A, 1.02.B.4, 1.04.B, 1.05.B, 2.02.A	Add requirements for ENVISION Sustainability Rating System





SECTION 06690

SOLID SURFACING FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Countertops with sinks
2. Laboratory countertops
3. Lavatory tops with undermount bowls
4. Lavatory tops with integral bowls
5. Reception areas/nurses' stations
6. Vanity tops
7. Tabletops
8. Bar tops
9. Seats
10. Cold cafeteria surfaces
11. Hot cafeteria surfaces
12. Windowsills
13. Thermoforming
14. Cove backsplashes
15. Color inlays

B. Related Requirements:

1. Section 01330 - Submittal Procedures
2. Section 01780 - Closeout Submittals
3. Section 05500 - Metal Fabrications
4. Section 06105 - Miscellaneous Carpentry
5. Section 10155 - Toilet Compartments
6. Section 15410 - Plumbing Fixtures
7. Section 16140 - Wiring Devices

1.02 REFERENCES

A. Definitions:

1. Solid surface is defined as nonporous, homogeneous material maintaining the same composition throughout the part with a composition of acrylic polymer, aluminum trihydrate filler and pigment

B. Reference Standards:

1. ASTM International (ASTM):



- a. ASTM D 256 - Standard Test Method for Determining the IZOD Pendulum Impact Resistance of Plastics.
- b. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.
- c. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- d. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 Degrees C with a Vitreous Silica Dilatometer.
- e. ASTM D 785 - Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
- f. ASTM D 790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- g. ASTM D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
- h. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- i. ASTM G 22 - Standard Practice for Determining Resistance of Plastics to Bacteria (Withdrawn 2001).
- j. ASTM G 155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.
- k. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- l. ASTM E 238 - Standard Test Method for Pin-Type Bearing Test of Metallic Materials.
- 2. International Association of Plumbing and Mechanical Officials (IAPMO):
 - a. ANSI/IAPMO Z124.3 – Plastic Lavatories.
 - b. ANSI/IAPMO Z124.6 – Plastic Sinks.
- 3. National Fire Protection Association (NFPA):
 - a. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.
- 4. National Science Foundation (NSF):
 - a. NSF/ANSI 51 – Food Equipment Materials.
- 5. Underwriters Laboratories, Inc. (UL):
 - a. UL 723 – Tests for Surface Burning Characteristics of Building Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordination drawings:
 - a. Shall be prepared indicating:



- 1) Plumbing work.
 - 2) Electrical work.
 - 3) Miscellaneous steel for the general work.
 - 4) Indicate location of all walls (rated and non-rated), blocking locations and recessed wall items, etc.
 - b. Content:
 - 1) Project-specific information, drawn accurately to scale.
 - 2) Do not base coordination drawings on reproductions of the contract documents or standard printed data.
 - 3) Indicate dimensions shown on the contract drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements.
 - 4) Provide alternate sketches to designer for resolution of such conflicts.
 - a) Minor dimension changes and difficult installations will not be considered changes to the contract.
 - c. Drawings shall:
 - 1) Be produced in 1/2-inch scale for all fabricated items.
 - d. Drawings must be complete and submitted to the Program/Project Manager within 60 days after award of contract for record only.
 - 1) No review or approval will be forthcoming.
 - 2) Coordination drawings are required for the benefit of contractor's fabricators/installers as an aid to coordination of their work so as to eliminate or reduce conflicts that may arise during the installation of their work.
- B. Pre-Installation Meetings:
1. Conduct conference at project site to comply with requirements in Division 1.

1.04 SUBMITTALS

- A. Action Submittals:
1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) For each type of product indicated.
 - b. Shop Drawings:
 - 1) Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices and other components.



- a) Show full-size details, edge details, thermoforming requirements, attachments, etc.
 - b) Show locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
 - c) Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in solid surface.
 - c. Samples:
 - 1) For each type of product indicated.
 - a) Submit minimum 6-inch by 6-inch sample in specified gloss.
 - b) Cut sample and seam together for representation of inconspicuous seam.
 - c) Indicate full range of color and pattern variation.
 - 2) Approved samples will be retained as a standard for work.
 - d. Certificates:
 - 1) Fabricator/Installer's qualifications.
 - 2) Manufacturer's technical representative's qualifications
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Sustainable Design Submittals:
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 2) ENVISION Credit RA 1.4 – Use Regional Materials
 - a) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:



- a. Operation and Maintenance Data:
 - 1) Submit manufacturer's care and maintenance data, including repair and cleaning instructions.
 - a) Maintenance kit for finishes shall be submitted.
 - 2) Provide maintenance requirements as specified by the manufacturer.

1.05 QUALITY ASSURANCE

A. Qualifications:

- 1. Shop that employs skilled workers who custom fabricate products similar to those required for this project and whose products have a record of successful in-service performance.

B. Certifications:

- a. Certificates:
 - 1) Fabricator/Installer's qualifications.
 - 2) Manufacturer's technical representative's qualifications

C. Sustainability Standards Certifications:

- a. Sustainable Design Submittals:
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 2) ENVISION Credit RA 1.4 – Use Regional Materials
 - a) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

D. Site Samples:

- a. Samples:
 - 1) For each type of product indicated.
 - a) Submit minimum 6-inch by 6-inch sample in specified gloss.
 - b) Cut sample and seam together for representation of inconspicuous seam.
 - c) Indicate full range of color and pattern variation.



2) Approved samples will be retained as a standard for work.

E. Mock-Ups:

1. Prior to fabrication of architectural millwork, erect sample unit to further verify selections made under sample submittals and to demonstrate the quality of materials and execution.
2. Mock-up shall be TBD.
3. Build the mock-up to comply with the contract documents and install in a location as directed by the Program/Project Manager.
4. Notify the Program/Project Manager two weeks in advance of the date of when the mock-up will be delivered.
5. Should mock-up not be approved, re-fabricate and reinstall until approval is secured.
 - a. Remove rejected units from project site.
6. After approval, the mock-up may become a part of the project.
7. This mock-up, once approved, shall serve as a standard for judging quality of all completed units of work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver no components to project site until areas are ready for installation.

B. Storage and Handling Requirements:

1. Store components indoors prior to installation.
2. Handle materials to prevent damage to finished surfaces.
 - a. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Provide manufacturer's warranty against defects in materials.
 - a. Warranty shall provide material and labor to repair or replace defective materials.
 - b. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.
2. Optional Installed Warranty:
 - a. To qualify for the optional Installed Warranty, fabrication and installation must be performed by a DuPont Certified Fabrication/Installation source who will provide a brand plate for the application.



- b. This warranty covers all fabrication and installation performed by the certified/approved source subject to the specific wording contained in the Installed Warranty Card.
- 3. Manufacturer's warranty period:
 - a. Ten years from date of substantial completion.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with requirements, provide products by one of the following:
 - 1) Corian® surfaces from the DuPont company (basis of design).
 - 2) Insert manufacturer's name.
- B. Design Criteria:
 - a. Product Data:
 - 1) For each type of product indicated.
 - b. Shop Drawings:
 - 1) Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices and other components.
 - a) Show full-size details, edge details, thermoforming requirements, attachments, etc.
 - b) Show locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
 - c) Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in solid surface.
- C. Materials:
 - 1. Solid polymer components
 - a. Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.
 - b. Superficial damage to a depth of 0.010 inch (.25 mm) shall be repairable by sanding and/or polishing.
 - 2. Thickness:
 - a. 1/4 inch



- b. 1/2 inch
 - c. 3/4 inch
- 3. Edge treatment:
 - a. *TBD*.
 - b. *TBD*.
 - c. As indicated
- 4. Inlays:
 - a. Fabricate using manufacturer's approved method.
 - b. Rout 1/8" deep max. groove for inlay to pattern indicated on designer's drawings.
 - c. Fill groove using methods approved by manufacturer, avoiding air bubbles or voids.
 - d. Overfill inlay area.
 - e. Allow area to fully cure.
 - 1) Do not overheat inlay while sanding.
 - f. Finish and touch up to uniform appearance.
 - g. Provide full *TBD* with contrasting color inlay in center of edge.
 - 1) Color *TBD*.
- 5. Integral sink:
 - a. Model number:
 - 1) *TBD*.
 - 2) *TBD*.
 - 3) *TBD*.
 - b. Color:
 - 1) *TBD*.
 - 2) *TBD*.
 - c. Mounting:
 - 1) Seamed; undermount.
- 6. Integral vanity:
 - a. Model number:
 - 1) *TBD*.
 - 2) *TBD*.
 - 3) *TBD*.
 - b. Color:
 - 1) *TBD*.
 - 2) *TBD*.
 - 3) *TBD*.
 - c. Mounting:
 - 1) Seamed; undermount.
- 7. Backsplash:
 - a. Applied.



- b. Coved.
- 8. Sidesplash:
 - a. Applied.
 - b. Coved.
- 9. Performance characteristics:



Property	Typical Result	Test
Tensile Strength	6,000 psi	ASTM D 638
Tensile Modulus	1.5×10^{-6} psi	ASTM D 638
Tensile Elongation	0.4% min.	ASTM D 638
Flexural Strength	10,000 psi	ASTM D 790
Flexural Modulus	1.2×10^{-6} psi	ASTM D 790
Hardness	>85	Rockwell "M" Scale ASTM D 785
	56	Barcol Impressor ASTM D 2583
Thermal Expansion	3.02×10^{-5} in./in./°C (1.80×10^{-5} in./in./°F)	ASTM D 696
Gloss (60° Gardner)	5–75 (matte—highly polished)	ANSI Z124
Light Resistance	(Xenon Arc) No effect	NEMA LD 3-2000 Method 3.3
Wear and Cleanability	Passes	ANSI Z124.3 & Z124.6
Stain Resistance: Sheets	Passes	ANSI Z124.3 & Z124.6
Fungus and Bacteria Resistance	Does not support microbial growth	ASTM G21&G22
Boiling Water Resistance	No visible change	NEMA LD 3-2000 Method 3.5
High Temperature Resistance	No change	NEMA LD 3-2000 Method 3.6
Izod Impact (Notched Specimen)	0.28 ft.-lbs./in. of notch	ASTM D 256 (Method A)
Ball Impact	No fracture—1/2 lb. ball:	NEMA LD 3-2000
Resistance	1/4" slab—36" drop 1/2" slab-144" drop	Method 3.8



Property	Typical Result	Test
Weatherability	$\Delta E^*_{94} < 5$ in 1,000 hrs	ASTM G 155
Specific Gravity †	1.7	
Water Absorption	Long-term 0.4% (3/4") 0.6% (1/2") 0.8% (1/4")	ASTM D 570
Toxicity	99 (solid colors) 66 (patterned colors)	Pittsburgh Protocol Test ("CL50" Test)
Flammability	All colors (Class I and Class A)	ASTM E 84, NFPA 255 & UL 723
Flame Spread Index	<25	
Smoke Developed Index	<25	

† Approximate weight per square foot: 1/4" (6 mm) 2.2 lbs., 1/2" (12.3 mm) 4.4 lbs.

Shapes meet or exceed the ANSI Z124.3 and ANSI Z124.6 standards for plastic sinks and lavatories.

NEMA results based on the NEMA LD 3-2000



D. Fabrication:

1. Shop Fabrication:

- a. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's printed instructions and technical bulletins.
- b. Form joints between components using manufacturer's standard joint adhesive without conspicuous joints.
- c. Reinforce with strip of solid polymer material, 2" wide.
- d. Provide factory cutouts for plumbing fittings and bath accessories as indicated on the drawings.
- e. Rout and finish component edges with clean, sharp returns.
 - 1) Rout cutouts, radii and contours to template.
 - 2) Smooth edges.
 - 3) Repair or reject defective and inaccurate work.

2. Thermoforming:

- a. Comply with manufacturer's data.
- b. Heat entire component.
 - 1) Material shall be uniform, between 275 and 325 degrees Fahrenheit during forming.
- c. Form pieces to shape prior to seaming and joining.
- d. Cut pieces to finished dimensions.
- e. Sand edges and remove nicks and scratches.

E. Finishes:

1. Shop Finishing Methods:

- a. Select from the manufacturer's standard color chart.
 - 1) Color:
 - a) *TBD.*
 - b) *TBD.*
 - c) *TBD.*
- b. Finish:
 - 1) Provide surfaces with a uniform finish.
 - a) Matte; gloss range of 5–20.
 - (1) Color
 - (2) Color
 - (3) Color
 - b) Semigloss; gloss range of 20–50.
 - (1) Color
 - (2) Color
 - (3) Color
 - c) Polished; gloss range of 50–80.



- (1) Color
- (2) Color
- (3) Color

2.02 ACCESSORIES

- A. Joint adhesive:
 - 1. Manufacturer's standard one- or two-part adhesive kit to create inconspicuous, nonporous joints.
- B. Sealant:
 - 1. Manufacturer's standard mildew-resistant, FDA-compliant, NSF 51-compliant (food zone — any type), UL-listed silicone sealant in colors matching components.
- C. Sink/lavatory mounting hardware:
 - 1. Manufacturer's standard bowl clips, panel inserts and fasteners for attachment of undermount sinks/lavatories.
- D. Conductive tape:
 - 1. Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.
- E. Insulating felt tape:
 - 1. Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine substrates and conditions, with fabricator present for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 - 1. Provide product in the largest pieces available.



2. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
 - a. Exposed joints/seams shall not be allowed.
 3. Reinforce field joints with solid surface strips extending a minimum of 1 inch on either side of the seam with the strip being the same thickness as the top.
 4. Cut and finish component edges with clean, sharp returns.
 5. Rout radii and contours to template.
 6. Anchor securely to base cabinets or other supports.
 7. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
 8. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 9. Install countertops with no more than 1/8-inch (3 mm) sag, bow or other variation from a straight line.
- B. Coved backsplashes and applied sidesplashes:
1. Install applied sidesplashes using manufacturer's standard color-matched silicone sealant.
 2. Adhere applied sidesplashes to countertops using manufacturer's standard color-matched silicone sealant.
- C. Coved backsplashes and sidesplashes:
1. Provide coved backsplashes and sidesplashes at all walls and adjacent millwork.
 2. Fabricate radius cove at intersection of counters with backsplashes to dimensions shown on the drawings.
 3. Adhere to countertops using manufacturer's standard color-matched Joint Adhesive.
- D. Color inlays:
1. Comply with product data from manufacturer.
 2. Rout groove for inlay to straight edge or pattern indicated on drawings.
 3. Fill groove using material furnished by manufacturer.
 4. Cure inlay, finish and touch up to uniform appearance.
- E. Integral sinks/vanities:
1. Provide solid surface materials bowls and/or lavatories sinks with overflows in locations shown on the drawings.
 2. Secure sinks and lavatory bowls to tops using manufacturer's recommended sealant, adhesive and mounting hardware to maintain warranty.



3.03 SCHEDULE

A. Reception areas:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>
f. Backsplash _____	<u>TBD</u>
g. Sidesplash _____	<u>TBD</u>

B. Seats:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>

C. Laboratory tops:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>
f. Backsplash _____	<u>TBD</u>
g. Sidesplash _____	<u>TBD</u>
h. Sink _____	<u>TBD</u>

D. Countertops:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>



- | | |
|---------------------|------------------|
| f. Backsplash _____ | _____ <u>TBD</u> |
| g. Sidesplash _____ | _____ <u>TBD</u> |

E. Bar tops:

1. Surfaces of material adhesively joined with inconspicuous seams.

- | | Color |
|-------------------------------|------------------|
| a. Vertical Thickness _____ | _____ <u>TBD</u> |
| b. Horizontal Thickness _____ | _____ <u>TBD</u> |
| c. Inlay _____ | _____ <u>TBD</u> |
| d. Edge Details _____ | _____ <u>TBD</u> |
| e. Finish _____ | _____ <u>TBD</u> |
| f. Backsplash _____ | _____ <u>TBD</u> |
| g. Sidesplash _____ | _____ <u>TBD</u> |
| h. Sink _____ | _____ <u>TBD</u> |

F. Countertops with undermount stainless steel or porcelain sinks:

1. Surfaces of material adhesively joined using silicone sealant.

- | | Color |
|-------------------------------|------------------|
| a. Vertical Thickness _____ | _____ <u>TBD</u> |
| b. Horizontal Thickness _____ | _____ <u>TBD</u> |
| c. Inlay _____ | _____ <u>TBD</u> |
| d. Edge Details _____ | _____ <u>TBD</u> |
| e. Finish _____ | _____ <u>TBD</u> |
| f. Backsplash _____ | _____ <u>TBD</u> |
| g. Sidesplash _____ | _____ <u>TBD</u> |
| h. Sink _____ | _____ <u>TBD</u> |

G. Countertops with seamed undermount solid surface sinks:

1. Surfaces of material adhesively joined with inconspicuous seams.

- | | Color |
|-------------------------------|------------------|
| a. Vertical Thickness _____ | _____ <u>TBD</u> |
| b. Horizontal Thickness _____ | _____ <u>TBD</u> |
| c. Inlay _____ | _____ <u>TBD</u> |
| d. Edge Details _____ | _____ <u>TBD</u> |
| e. Finish _____ | _____ <u>TBD</u> |
| f. Backsplash _____ | _____ <u>TBD</u> |
| g. Sidesplash _____ | _____ <u>TBD</u> |
| h. Sink _____ | _____ <u>TBD</u> |

H. Countertops with traditional undermount lavatories:

1. Surfaces of material adhesively joined with silicone sealant.



	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>
f. Backsplash _____	<u>TBD</u>
g. Sidesplash _____	<u>TBD</u>
h. Sink _____	<u>TBD</u>

I. Integral vanity tops and lavatories:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>
f. Backsplash _____	<u>TBD</u>
g. Sidesplash _____	<u>TBD</u>
h. Sink _____	<u>TBD</u>

J. Windowsills:

1. Surfaces of material adhesively joined with inconspicuous seams.

	Color
a. Vertical Thickness _____	<u>TBD</u>
b. Horizontal Thickness _____	<u>TBD</u>
c. Inlay _____	<u>TBD</u>
d. Edge Details _____	<u>TBD</u>
e. Finish _____	<u>TBD</u>

3.04 REPAIR

- A. Repair or replace damaged work which cannot be repaired to Program/Project Manager's satisfaction.

3.05 CLEANING

- A. Keep components clean during installation.
- B. Remove adhesives, sealants and other stains.



3.06 MAINTENANCE

- a. Operation and Maintenance Data:
 - 1) Submit manufacturer's care and maintenance data, including repair and cleaning instructions.
 - a) Maintenance kit for finishes shall be submitted.
 - 2) Provide maintenance requirements as specified by the manufacturer.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 07132

SELF-ADHERING SHEET WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of self-adhering sheet waterproofing:
 - a. Butyl rubber sheet waterproofing.
 - b. Ethylene propylene diene terpolymer (EPDM) rubber sheet waterproofing.
 - c. Polyethylene sheet waterproofing.
 - d. Modified Bituminous sheet waterproofing
 - e. Molded-sheet drainage panels.
 - f. Insulation.
 - g. Self-adhesive HDPE waterproofing membrane.
 - h. Pre-applied HDPE waterproofing membrane.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene propylene diene terpolymer M-class rubber.
 - 2. HDPE: High density polyethylene.
 - 3. RCPS: Rigid cellular polystyrene.
 - 4. UV: Ultraviolet radiation.
 - 5. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 272 – Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.



- b. ASTM C 578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- c. ASTM C 836 – Standard Specification for High Solids Content, Cold Liquid Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
- d. ASTM D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.
- e. ASTM D 570 – Standard Test Method for Water Absorption of Plastics.
- f. ASTM D 882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- g. ASTM D 903 – Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
- h. ASTM D 1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
- i. ASTM D 1876 – Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
- j. ASTM D 1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
- k. ASTM D 3767 – Standard Practice for Rubber--Measurement of Dimensions.
- l. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.
- m. ASTM D 5385 – Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
- n. ASTM D 5843 – Standard Guide for Application of Fully Adhered Vulcanized Rubber Sheets Used in Waterproofing.
- o. ASTM D 6134 – Standard Specification for Vulcanized Rubber Sheets Used in Waterproofing Systems.
- p. ASTM D 6506 – Standard Specification for Asphalt Based Protection Board for Below-Grade Waterproofing.
- q. ASTM E 96/E 96M – Standard Test Methods for Water Vapor Transmission of Materials.
- r. ASTM E 154 – Standard Test Methods for Water Vapor Retarders Used in Contact With Earth Under Concrete Slabs, on Walls, or as Ground over.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Meetings:



1. Conduct a Pre-Installation Conference with the Program/Project Manager at the Site in accordance with the requirements specified in Section 01316, Project Meetings.
 - a. In the meeting agenda, include a review of waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Self-adhering sheet waterproofing.
 - b. Shop Drawings:
 - 1) Self-adhering sheet waterproofing.
 - c. Samples:
 - 1) Sample of each type of self-adhering sheet waterproofing to be provided under this Contract.
 - d. Qualification Statements:
 - 1) Self-adhering sheet waterproofing installer's qualifications.
 - 2) Self-adhering sheet waterproofing manufacturer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturers' written installation instructions.
 - 2) Manufacturers' written seam construction instructions
 - b. Manufacturer's Reports:
 - 1) Manufacturers' test reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Butyl Rubber Sheet Waterproofing Warranty.
 - 2) Ethylene Propylene Diene Terpolymer M-Class (EPDM) Rubber Sheet Waterproofing Warranty.
 - 3) High Density Polyethylene (HDPE) Sheet Waterproofing Membrane Warranty.



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Self-Adhering Sheet Waterproofing Installer's Qualifications:
 - a. Employ a firm that is approved or licensed by the waterproofing manufacturer to install the self-adhering sheet waterproofing products to be installed under this Contract.
 - b. Submit the self-adhering sheet waterproofing installer's qualifications to the Program/Project Manager for approval.
2. Self-Adhering Sheet Waterproofing Manufacturer's Qualifications:
 - a. Obtain the self-adhering sheet waterproofing products from a manufacturer that has a minimum of 25 years' experience manufacturing waterproofing membrane underlayments.
 - b. Submit the self-adhering sheet waterproofing manufacturer's qualifications to the Program/Project Manager for approval.

B. Site Samples:

1. Submit a manufacturer's Sample of each type of self-adhering sheet waterproofing to be provided under this Contract to the Program/Project manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver the self-adhering sheet waterproofing materials in their original unopened packages, containers, or bundles bearing the brand name and identification of the manufacturer or Supplier.
 - a. Include Material Safety Data Sheets that indicate proper handling and disposal methods for each material.

B. Storage and Handling Requirements:

1. Store the self-adhering sheet waterproofing materials under cover.
2. Do not double stack palletized material.

C. Packaging Waste Management:

1. Remove disposable release sheets from the self-adhering sheet waterproofing immediately prior to using the material.
2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Only apply waterproofing when the ambient and substrate temperatures are within the range recommended by the waterproofing manufacturer.



1.08 WARRANTY

A. Special Warranty:

1. Butyl Rubber Sheet Waterproofing Warranty:
 - a. Obtain a manufacturer's warranty for the Type 1 self-adhering butyl rubber sheet waterproofing materials on the manufacturer's standard or customized form, in which the manufacturer agrees, without monetary limitation, to replace waterproofing materials that do not comply with the specified requirements or that fail to remain watertight within the warranty period that begins on the Date of Substantial Completion and continues after that date for 20 years.
 - b. Submit the written Butyl Rubber Sheet Waterproofing Warranty for the specified warranty period to the Program/Project Manager for approval.
2. Ethylene Propylene Diene Terpolymer M-Class (EPDM) Rubber Sheet Waterproofing Warranty:
 - a. Obtain a manufacturer's warranty for the Type 2 self-adhering ethylene propylene diene terpolymer M-Class (EPDM) rubber sheet waterproofing materials on the manufacturer's standard or customized form, in which the manufacturer agrees, without monetary limitation, to replace waterproofing materials that do not comply with the specified requirements or that fail to remain watertight within the warranty period that begins on the Date of Substantial Completion and continues after that date for 20 years.
 - b. Submit the written Ethylene Propylene Diene Terpolymer M-Class (EPDM) Rubber Sheet Waterproofing Warranty for the specified warranty period to the Program/Project Manager for approval.
3. Modified Bituminous Sheet Waterproofing Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warrant period of 5 years from date of substantial completion.
4. High Density Polyethylene (HDPE) Sheet Waterproofing Membrane Warranty:
 - a. Obtain a manufacturer's warranty for the Type 3 self-adhering high-density polyethylene (HDPE) sheet waterproofing membrane materials on the manufacturer's standard or customized form, in which the manufacturer agrees, without monetary limitation, to replace waterproofing materials that do not comply with the specified requirements or that fail to remain watertight within the warranty period that begins on the Date of Substantial Completion and continues after that date for 10 years.
 - b. Submit the written High-Density Polyethylene (HDPE) Sheet Waterproofing Membrane Warranty for the specified warranty period to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 SELF-ADHERING SHEET WATERPROOFING SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain self-adhering sheet waterproofing from single source from single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Design Criteria:
 - 1. Provide watertight self-adhering sheet waterproofing of the types specified herein at the locations indicated in the Contract Documents.
 - 2. Provide the auxiliary materials recommended by the waterproofing manufacturer for the intended use and compatible with the sheet waterproofing.
 - a. Provide waterproofing and sheet flashing accessories including sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by the waterproofing manufacturer for the intended application.
 - b. Furnish liquid-type auxiliary materials that comply with the volatile organic compounds (VOC) limits of the Authorities Having Jurisdiction.
 - 3. Product Data:
 - a. Obtain Product Data from the self-adhering sheet waterproofing manufacturer, including the manufacturer's product data sheets, technical data, product test reports, Material Safety Data Sheets, tested physical and performance properties of the waterproofing materials, and the manufacturer's written instructions for evaluating, preparing, and treating the substrates where the self-adhering sheet waterproofing will be applied.



- b. Submit the Product Data to the Program/Project Manager for approval.
- 4. Shop Drawings:
 - a. Prepare Shop Drawings of the self-adhering sheet waterproofing showing the locations and extent of the waterproofing to be provided under this Section.
 - 1) Include details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.

D. Materials:

- 1. Self-Adhering Sheet Waterproofing:
 - a. Type 1 - Butyl Rubber Sheet Waterproofing:
 - 1) Provide flexible, unreinforced, self-adhering isobutylene-isoprene rubber sheets formed from material complying with the requirements for Type II butyl rubber sheets specified in ASTM D 6134.
 - 2) Thickness:
 - a) Provide butyl rubber sheets that are 60 mils (1.5mm) thick.
 - 3) Manufacturers:
 - a) Carlisle Coatings & Waterproofing Inc.; Sure-Seal Butyl, www.carlisle-ccw.com.
 - b) Approved Equal.
 - b. Type 2 - Ethylene Propylene Diene Terpolymer M-Class (EPDM) Rubber Sheet Waterproofing:
 - 1) Provide flexible, unreinforced, self-adhering ethylene propylene diene terpolymer M-class (EPDM) rubber sheet complying with the requirements for Type I EPDM specified in ASTM D 6134.
 - 2) Thickness:
 - a) Provide ethylene propylene diene terpolymer M-class (EPDM) rubber sheets that are 60 mils (1.5mm) thick.
 - 3) Manufacturers:
 - a) Carlisle Coatings & Waterproofing Inc.; Sure-Seal EPDM, www.carlisle-ccw.com.
 - b) Approved Equal.
 - c. Type 3 – Modified Bituminous Waterproofing Membrane:
 - 1) Not less than 60 mil (1.5 mm) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil (0.10 mm) thick polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
 - 2) Manufacturers:



- a) Grace, W.R. & Co.; Bituthene 3000;
www.graceconstruction.com
- b) Approved Equal
- d. Type 4 - HDPE Sheet Waterproofing Membrane:
 - 1) Provide a flexible, pre-formed waterproof membrane which combines a high performance, cross laminated, HDPE carrier film having a unique, super tacky, self-adhesive rubberized asphalt compound.
 - a) Provide HDPE sheet waterproofing membrane having the properties specified in Table 07132-2.

Table 07132-1 Type 3 HDPE Waterproofing Membrane Properties		
Property	Test Method	Required Value
Color	N/A	Dark gray-black
Thickness	ASTM D 3767-Method A	1/16 in. (1.5mm) normal
Flexibility, 180 degree bend over a 1 inch (25mm) mandrel at -25°F (-32°C)	ASTM D 1970	Unaffected
Tensile strength, membrane, die C	ASTM D 412 modified ⁽¹⁾	325 lbs/in. ² (2240kPa) minimum
Tensile strength, film	ASTM D 882 modified ⁽¹⁾	5,000 lbs/in. ² (34.5MPa) minimum
Elongation, ultimate failure of rubberized asphalt	ASTM D 412 modified ⁽¹⁾	300 percent minimum
Crack cycling at -25°F (-32°C), 100 cycles	ASTM C 836	Unaffected
Lap adhesion at minimum application temperature	ASTM D 1876 modified ⁽²⁾	5 pounds per inch (800N/m)
Peel strength	ASTM D 903 modified ⁽³⁾	9 pounds per inch (1576N/m)



Table 07132-1 Type 3 HDPE Waterproofing Membrane Properties		
Property	Test Method	Required Value
Puncture resistance, membrane	ASTM E 154	50 pounds (9222N) minimum
Resistance to hydrostatic head	ASTM D 5385	210 feet (70m) of water
Permeance	ASTM E 96/E 96M, section 12 Water Method	0.05 perms (2.9ng/m ² sPa) maximum
Water absorption	ASTM D 570	0.1 percent maximum
<ol style="list-style-type: none">1. Run the test at a rate of 2 inches (50mm) per minute.2. Conduct the test 15 minutes after the lap is formed, and at a rate of 2 inches (50mm) per minute at 40 degrees Fahrenheit (5° C).3. Run the peel strength test at a rate of 12 inches (300mm) per minute.		

- b) Provide HDPE sheet waterproof membrane having a surface conditioner consisting of a water-based latex surface treatment which imparts an aggressive, high tack finish to the treated substrate, and has the properties specified in Table 07132-3.

Table 07132-2 Type 3 HDPE Waterproofing Membrane Surface Conditioner Properties	
Property	Required Value
Solvent type	Water
Flash point	>140° F (>60° C)
Volatile Organic Compound (VOC) content	91 g/L
Application temperature	25° F (-4° C) and above
Freeze thaw stability	5 cycles (minimum)
Freezing point (as packaged)	14° F (-10° C)
Dry time (hours)	1 hour ⁽¹⁾
<ol style="list-style-type: none">1. Dry time will vary with weather conditions.	



- c) Manufacturer:
 - (1) W. R. Grace and Company, Grace Construction Products, Bituthene System 4000. www.graceconstruction.com.
 - (2) Approved equal.

2.02 ACCESSORIES

- A. Concealed Sheet Flashing:
 - 1. Provide the concealed sheet flashing recommended by the manufacturer, and fabricated from the same material, and having the same construction and thickness, as the sheet waterproofing; or uncured ethylene propylene diene terpolymer M-class (EPDM) rubber sheet that is 60 mils (1.5mm) thick.
- B. Exposed Sheet Flashing:
 - 1. Provide the exposed sheet flashing recommended by the manufacturer, and fabricated from cured or uncured ethylene propylene diene terpolymer M-class (EPDM) rubber sheet that is 60 mils (1.5mm) thick.
- C. Bonding Adhesives:
 - 1. Provide adhesive suitable for bonding the polymeric sheets and sheet flashings to the substrates and projections.
- D. Butyl Splicing Cement and Cleaner:
 - 1. Provide single-component butyl splicing cement and solvent-based splice cleaner.
- E. Butyl Gum Tape:
 - 1. Provide butyl gum tape consisting of uncured butyl that is 30 mils (0.76mm) thick and 6-1/4 inches (160mm) wide, and that has polyethylene release film.
- F. Lap Sealant:
 - 1. Provide single-component lap sealant.
- G. In-Seam Sealant:
 - 1. Provide single-component in-seam sealant.
- H. Water Cutoff Mastic:
 - 1. Provide butyl mastic sealant.
- I. Metal termination Bars:
 - 1. Provide the manufacturer's standard pre-punched aluminum bars, approximately 1 inch (25mm) wide, and having zinc-alloy-body fasteners and stainless-steel pins.



J. Protection Course:

1. Protection Board:

- a. Provide protection board complying with the requirements specified in ASTM D 6506, and consisting of semi-rigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between 2 asphalt-saturated fibrous liners.

1) Thickness:

- a) For vertical applications, provide protection board having a nominal thickness of 1/8 inch (3mm).
- b) For non-vertical applications, provide protection board having a nominal thickness of 1/4 inch (6mm).

b. Adhesive:

- 1) Provide the rubber-based solvent type adhesive recommended by the waterproofing manufacturer for the type of protection course provided.

2. Faced Polystyrene Board Protection Course:

- a. Provide a faced, fan-folded, protection course consisting of a core of extruded-polystyrene board insulation sandwiched between 2 sheets of plastic film

b. Thickness:

- 1) Provide polystyrene board having a nominal thickness of 1/4 inch (6 mm).

c. Compressive Strength:

- 1) Provide polystyrene board having compressive strength not less than 8 psi (55kPa) when tested in accordance with the method specified in ASTM D 1621.

d. Water Absorption:

- 1) Provide polystyrene board having maximum water absorption by volume of 0.6 percent when tested in accordance with the method specified in ASTM C 272.

3. Un-Faced Polystyrene Protection Course:

- a. Provide an un-faced, fan-folded, extruded-polystyrene board insulation protection course.

b. Thickness:

- 1) Provide polystyrene board having a nominal thickness of 1/4 inch (6mm).

c. Compressive Strength:

- 1) Provide polystyrene board having compressive strength not less than 8 psi (55kPa) when tested in accordance with the method specified in ASTM D 1621.

4. Un-Faced Rigid Cellular Polystyrene (RCPS) Protection Course:

- a. Provide an un-faced, extruded-polystyrene board insulation protection course complying with the requirements for Type X rigid cellular polystyrene (RCPS) specified in ASTM C 578.

b. Thickness:



- 1) Provide polystyrene board having a nominal thickness of 1/2 inch (13mm).
 5. Molded-Polystyrene Protection Course:
 - a. Provide molded-polystyrene board insulation complying with the requirements for Type I rigid cellular polystyrene (RCPS) specified in, ASTM C 578.
 - b. Density
 - 1) Provide molded-polystyrene board having a minimum density of 0.90 pounds per cubic foot (15kg/m³).
 - c. Thickness:
 - 1) Provide molded-polystyrene board having a minimum thickness of 1 inch (25mm).
- K. Molded-Sheet Drainage Panels:
 1. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels:
 - a. Provide manufactured composite subsurface drainage panels consisting of a studded, non-biodegradable, molded-plastic-sheet drainage core having a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding a No. 70 (0.21mm) sieve size laminated to one side [and a polymeric film bonded to the other side].
 - b. Flow Rate:
 - 1) Provide drainage panels having a vertical flow rate of 9 gallons per minute per foot to 15 gallons per minute per foot (112L/min./m to 188L/min./m).
 2. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels:
 - a. Provide manufactured composite subsurface drainage panels consisting of a studded, non-biodegradable, molded-plastic-sheet drainage core having a woven-geotextile facing with an apparent opening size not exceeding a No. 40 (0.425mm) sieve size laminated to one side [and a polymeric film bonded to the other side].
 - b. Flow Rate:
 - 1) Provide drainage panels having a horizontal flow rate not less than 2.8 gallons per minute per foot (35L/min./m).
- L. Insulation:
 1. Board Insulation:
 - a. Provide square edged extruded-polystyrene board insulation complying with the requirements specified in ASTM C 578, and of a Type having the required minimum compressive strength as follows:
 - 1) Type IV has a minimum compressive strength of 25 psi (173kPa).
 - 2) Type V has a minimum compressive strength of 100 psi (690kPa).
 - 3) Type VI has a minimum compressive strength of 40 psi (276kPa).
 - 4) Type VII has a minimum compressive strength of 60 psi (414kPa).
 2. Un-Faced Wall Insulation Drainage Panels:



- a. Provide un-faced extruded-polystyrene board insulation complying with the requirements for Type VII rigid cellular polystyrene (RCPS) specified in ASTM C 578, and fabricated with grooved drainage channels on 1 side and shiplapped or channel edges.
3. Geotextile-Faced Wall Insulation Drainage Panels:
 - a. Provide extruded-polystyrene board insulation complying with the requirements for Type VI rigid cellular polystyrene (RCPS) specified in ASTM C 578, faced with nonwoven geotextile filter fabric, and fabricated with grooved drainage channels on 1 side and tongue-and-groove edges.
4. Unfaced Plaza Deck Insulation Drainage Panels:
 - a. Provide un-faced extruded-polystyrene board insulation complying with the requirements for Type VII rigid cellular polystyrene (RCPS) specified in ASTM C 578, and fabricated with ribbed drainage channels on 1 side and shiplapped or channel edges.
5. Geotextile-faced Plaza Deck Insulation Drainage Panels:
 - a. Provide extruded-polystyrene board insulation complying with the requirements for Type VII rigid cellular polystyrene (RCPS) specified in ASTM C 578, faced with manufacturer's standard, nonwoven geotextile filter fabric, and fabricated with grooved drainage channels on 1 side and tongue-and-groove edges.

M. Polyethylene Sheet Waterproofing Primer:

1. Provide the polyethylene sheet primer recommended by the polyethylene sheet waterproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the deck areas that are indicated to receive polyethylene sheet waterproofing as a roof underlayment in the Contract Documents, such as plywood, wood composition, wood plank, metal, concrete, or gypsum sheathing, are clean, dry, and furnish a continuous structural deck.
 - a. Verify that the decks have no voids, damaged, or unsupported areas.
- B. Evaluation and Assessment:
 1. Prior to installing the self-adhering sheet waterproofing, notify the Program/Project Manager in writing of defects discovered which could affect the satisfactory completion of the Work of this Section.
 2. Do not apply self-adhering sheet waterproofing to damp or wet substrates.

3.02 PREPARATION

- A. Protection of In-Place Conditions:



1. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray from affecting other construction.

B. Surface Preparation:

1. Clean, prepare, and treat substrates according to the manufacturer's written instructions.
 - a. Repair damaged deck areas before installing polyethylene sheet waterproofing membranes.
 - b. Prepare, fill, prime, and treat joints and cracks in the substrates.
 - c. Insure that the substrates where waterproofing are to be applied are clean, dust-free, and dry.
 - 1) Remove dust and dirt from joints and cracks in accordance with the requirements specified in ASTM D 4258.
 - 2) Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
 - 3) Remove dust, dirt, loose nails, and old roofing materials from deck areas to receive polyethylene sheet waterproofing as a roof underlayment.
2. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through the waterproofing and at drains and protrusions.
3. In areas that are to receive polyethylene sheet waterproofing, apply the primer recommended by the waterproofing manufacturer to concrete, masonry, wood composition, and gypsum board surfaces.

C. Demolition/Removal:

1. Remove fins, ridges, mortar, and other projections; and fill honeycomb, aggregate pockets, holes, and other voids.
2. Remove protrusions from deck areas that are to receive polyethylene sheet waterproofing as a roof underlayment.

3.03 INSTALLATION

A. Fully Adhered Sheet Waterproofing:

1. Install fully adhered waterproofing sheets over the entire area that is to receive waterproofing in accordance with the requirements of the fully adhered sheet waterproofing manufacturer's installation instructions, and with the recommendations in ASTM D 5843.
 - a. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.
2. Accurately align the sheets, and maintain uniform side and end laps that have the minimum dimensions required.
 - a. Stagger end laps.
3. Bonding Adhesive:
 - a. Apply bonding adhesive at the required rate to the substrates, and allow the bonding adhesive to partially dry.



- b. Apply bonding adhesive to the sheets, and firmly adhere the sheets to the substrates.
 - c. Do not apply the bonding adhesive to the splice area of the sheet.
 4. Install the fully adhered sheets and auxiliary materials so they tie into existing waterproofing.
 5. Horizontal Applications:
 - a. Apply the fully adhered sheets so the side laps are shingled with the slope of the deck wherever possible.
 - b. Spread a sealant bed over the deck drain flanges at deck drains, and securely seal the sheet waterproofing in place using a clamping ring.
- B. Partially Adhered Sheet Waterproofing:
 1. Install partially adhered waterproofing sheets over the entire area that is to receive waterproofing in accordance with the requirements of the partially adhered waterproofing manufacturer's written installation instructions.
 - a. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.
 2. Accurately align the sheets, and maintain uniform side and end laps that have the minimum dimensions required.
 - a. Stagger end laps.
 3. Bonding Adhesive:
 - a. Apply bonding adhesive at the required rate to the substrates under 25 percent of each sheet at the upper end, and under the 18-inch (457mm) strip along the perimeter of the remaining 3 sides of each sheet, and allow the bonding adhesive to partially dry.
 - b. Firmly adhere the sheets to the substrates.
 - c. Do not apply the bonding adhesive to the splice area of the sheet.
 4. Install the partially adhered sheets and auxiliary materials so they tie into existing waterproofing.
- C. Compartmented, Loosely Laid Sheet Waterproofing:
 1. Install compartmented, loosely laid sheets over the entire area to receive waterproofing according to the compartmented, loosely laid sheet waterproofing manufacturer's written instructions.
 - a. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.
 2. Accurately align the sheets, and maintain uniform side and end laps that have the minimum dimensions required.
 - a. Stagger end laps.
 3. Apply continuous beads of water cutoff mastic of the size recommended by the compartmented, loosely laid sheet waterproofing manufacturer to the substrates in a 60 inch by 60 inch (1500mm by 1500mm) grid pattern before installing the compartmented, loosely laid sheet waterproofing.
 4. Apply the compartmented, loosely laid sheets so the side laps are shingled with the slope of the deck wherever possible.



5. Spread a sealant bed over the deck drain flanges at deck drains, and securely seal the sheet waterproofing in place using a clamping ring.
6. Install the compartmented, loosely laid sheets and auxiliary materials so they tie into existing waterproofing.

D. Waterproofing Seams:

1. Cement Splices:
 - a. Clean the areas that are to receive cement splices.
 - b. Apply splicing cement and in-seam sealant, and firmly roll the side and end laps of overlapping sheets in accordance with the manufacturer's instructions to produce a splice that is not less than 6 inches (150mm) wide, and to ensure a watertight seam installation.
 - c. Apply lap sealant, and seal the exposed edges at sheet terminations.
2. Cement and Tape Splices:
 - a. Clean the areas that are to receive cement and tape splice.
 - b. Apply splicing cement and butyl gum tape, and firmly roll the side and end laps of overlapping sheets in accordance with the manufacturer's instructions to ensure a watertight seam installation.
 - c. Apply lap sealant, and seal exposed edges at sheet terminations.
3. Submit the manufacturers' written seam construction instructions to the Program/Project Manager for information.

E. Sheet Flashing:

1. Install sheet flashings and preformed flashing accessories, and adhere them to the substrates in accordance with the waterproofing manufacturer's written installation instructions.
2. Form wall flashings using exposed sheet flashing.
3. Extend deck sheet waterproofing to form wall flashings.
 - a. Flash penetrations and the field-formed inside and outside corners using uncured sheet flashing.
 - b. Clean splice areas, apply splicing cement, and firmly roll the side and end laps of overlapping sheets to ensure a watertight installation.
 - c. Apply lap sealant, and seal the exposed edges at sheet flashing terminations.
4. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending the deck sheet waterproofing over the joints.
5. Terminate and seal the tops of sheet flashings using mechanically anchored termination bars.

F. Protection Course:

1. Prior to beginning subsequent construction operations, install the protection course over the waterproofing membrane in accordance with the protection course manufacturer's installation instructions.
 - a. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.
2. Minimize exposure of the membrane.



3. For vertical applications, molded-sheet drainage panels, insulation drainage panels, or board insulation may be used in place of a separate protection course if its use is approved by the waterproofing manufacturer.

G. Molded-Sheet Drainage Panels:

1. Place and secure molded-sheet drainage panels, with the geotextile facing away from the wall or deck substrate, in accordance with the molded-sheet drainage panel manufacturer's installation instructions.
 - a. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.
 - b. Provide adhesives or mechanical fasteners that do not penetrate the waterproofing.
 - c. Lap the edges and ends of the geotextile so continuity is maintained.
 - d. For vertical applications, install the board insulation or protection course before installing the drainage panels.

H. Insulation:

1. Install one or more layers of board insulation as required to achieve the required thickness, and install insulation drainage panels, over the waterproofed surfaces.
 - a. Cut and fit the insulation to within 3/4 inch (19mm) of projections and penetrations.
2. Place and secure insulation units on vertical surfaces in accordance with the manufacturer's installation instructions.
3. Loosely lay insulation units on horizontal surfaces in accordance with the manufacturer's installation instructions.
 - a. Stagger end joints, and tightly abut insulation units.
4. Submit the manufacturers' written installation instructions to the Program/Project Manager for information.

3.04 REPAIR/RESTORATION

- A. Repair tears, voids, and lapped seams in the waterproofing that do not comply with the specified requirements.
1. Slit and flatten fishmouths and blisters.
 2. Provide patches using sheet waterproofing, and that extend beyond the repaired areas in all directions.

3.05 CLEANING

- A. Clean spillage onto and soiling of adjacent construction using cleaning agents and procedures recommended by the manufacturer of the affected construction.
- B. Waste Management:



1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Protect installed self-adhering sheet waterproofing from damage and wear during the remainder of the construction period.
 1. Do not permit foot or vehicular traffic on unprotected self-adhering sheet waterproofing membrane.
- B. Protect installed board insulation and insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes.
 1. Where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation, provide temporary coverings.
 2. Protect installed molded-sheet drainage panels during subsequent construction.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 07142

COLD FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for acrylic-based elastomeric waterproofing.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 - Cast-In-Place Concrete.
 - 5. Section 07620 - Sheet Metal Flashing and Trim.
 - 6. Section 07920 - Joint Sealants.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CGSB – Canadian General Standards Board.
 - 2. SNCF – The French national railway.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 836 – Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
 - b. ASTM C 898 – Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane With Separate Wearing Course.
 - c. ASTM C 1193 – Standard Guide for Use of Joint Sealants.
 - d. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
 - e. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.
 - f. ASTM D 4259 – Standard Practice for Abrading Concrete.
 - g. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - h. ASTM D 5957 – Standard Guide for Flood Testing Horizontal Waterproofing Installations.
 - i. ASTM D 7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
 - j. ASTM E 96/ E 96M – Standard Test Methods for Water Vapor Transmission of Materials.



2. Canadian General Standards Board (CGSB):
 - a. CAN/CGSB 37.50 M89 – Hot Applied, Rubberized Asphalt for Roofing and Waterproofing [*withdrawn*].
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. SNCF:
 - a. Dynamic ballast impact test.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency and the City prior to incorporating items requiring testing by them into the Work.
- B. Pre-Installation Meetings:
 1. Conduct a Pre-installation Conference at the Site to review waterproofing requirements, including surface preparation, substrate conditions and pretreatment, minimum curing periods, forecasted weather conditions, special details and flashings, installation procedures, testing and inspection procedures, protection, and repairs.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cold fluid-applied waterproofing membrane.
 - 2) Waterproofing membrane primer.
 - 3) Nonwoven-geotextile-faced, molded-sheet drainage panels.
 - 4) Woven-geotextile-faced, molded-sheet drainage panels.
 - b. Shop Drawings:
 - 1) Cold fluid-applied waterproofing.
 - c. Samples:
 - 1) Flashing sheet Sample.
 - 2) Membrane-reinforcing fabric Sample.
 - 3) Insulation Sample.
 - 4) Drainage Panel Samples.
 - d. Qualification Statements:



- 1) Cold Fluid-applied waterproofing installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Waterproofing.
 - b. Manufacturer's Instructions:
 - 1) Waterproofing manufacturer's written surface preparation recommendations.
 - 2) Waterproofing manufacturer's written instructions for preparing vertical and horizontal surfaces at terminations and penetrations.
 - 3) Waterproofing manufacturer's written application instructions.
 - c. Manufacturer's Reports:
 - 1) Daily reports from the technical site representative qualified by the waterproofing membrane manufacturer.
 - d. Qualification Data:
 - 1) Cold fluid-applied waterproofing installer's qualifications:

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Fluid-Applied Waterproofing Materials Warranty.
 - 2) Cold Fluid-Applied Waterproofing Installation Warranty.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Cold Fluid-Applied Waterproofing Installer's Qualifications:
 - a. Engage a firm that is certified by the waterproofing manufacturer to install the waterproofing specified for this Contract.
 - b. Submit the cold fluid-applied waterproofing installer's qualifications to the Program/Project Manager for approval.
 - 1) Include a list of at least 5 references for similar projects in North America completed to the client's satisfaction during the past 5 years in a similar environment and application.



C. Certifications:

1. Test and Evaluation Reports:

- a. Submit Test and Evaluation Reports for the waterproofing, proposed to be provided under this Section, to the Program/Project Manager for information.
- 1) Furnish test and evaluation reports based on evaluation of comprehensive tests performed by a qualified independent testing agency.

D. Site Samples:

1. Submit the following Samples to the Program/Project Manager for approval:
 - a. Flashing Sheet: 10-inch by 8-inch Sample.
 - b. Membrane-Reinforcing Fabric: 10-inch by 8-inch Sample.
 - c. Insulation: 10-inch by 8-inch Sample.
 - d. Drainage Panels: 4-inch by 4-inch Sample.

E. Mock-Ups:

1. Before beginning to apply the waterproofing materials for production Work, at a location determined by the Program/Project Manager apply waterproofing to 100 square feet of deck or wall to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality to the Program/Project Manager.
 - a. If the Program/Project Manager determines the mockups do not comply with the specified requirements, reapply waterproofing until the mockups are approved by the Program/Project Manager.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in the mockups, unless the Program/Project Manager specifically approves such deviations in writing.
 - c. Mock-ups applied as part of the building or structure as opposed to those erected separately may become part of the completed Work if approved by the Program/Project Manager and undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver liquid materials to the Site in their original containers with seals unbroken, labeled with the manufacturer's name, the product brand name and the type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Storage and Handling Requirements:



1. Store liquid materials in their original undamaged containers in a clean, dry, protected location, and within the temperature range required by the waterproofing manufacturer.
2. Remove and replace liquid materials that cannot be applied within their stated shelf life.
3. Protect stored materials from direct sunlight.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Apply waterproofing within the range of ambient and substrate temperatures recommended by the waterproofing manufacturer.
 - a. Do not apply waterproofing to damp or wet substrate, when the relative humidity exceeds 85 percent, or when temperatures are less than 14 degrees Fahrenheit if the substrate temperature is above the dew point.
 - 1) If conditions are outside of these ranges, consult the manufacturer.
 - b. Do not apply waterproofing in snow, rain, fog, or mist; or when these weather conditions are imminent during an application or curing period.
2. Maintain adequate ventilation during application and curing of waterproofing materials.

1.08 WARRANTY

A. Manufacturer Warranty:

1. Warrant the cold fluid-applied waterproofing materials against failures within the 5-year period after the Date of Substantial Completion:
 - a. Submit a Cold Fluid-Applied Waterproofing Materials Warranty on the manufacturer's standard or customized form, without monetary limitation, in which the manufacturer agrees to repair or replace waterproofing that fails to remain watertight within the specified warranty period to the Program/Project Manager for approval.
 - b. The Cold Fluid-Applied Waterproofing Materials Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to the specified requirements, or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

B. Special Warranty:

1. Special Installer's Warranty:



- a. Warrant the cold fluid-applied waterproofing workmanship against failures within the 5-year period after the Date of Substantial Completion:
 - 1) Include removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks in the Warranty.
 - 2) Submit a Cold Fluid-Applied Waterproofing Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair waterproofing that fails to remain watertight within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 WATERPROOFING SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain waterproofing materials, the protection course, and molded-sheet drainage panels from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Flow Rates of Molded-Sheet Drainage Panels:
 - a. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panels:
 - 1) Vertical Flow Rate:
 - a) Provide nonwoven-geotextile-faced, molded-sheet drainage panels having a vertical flow rate of 9 to 15 gallons per minute per foot (112 to 188 Liters per minute per meter).



- b. Woven-Geotextile-Faced, Molded-Sheet Drainage Panels:
- 1) Horizontal Flow Rate:
 - a) Provide woven-geotextile-faced, molded-sheet drainage panels having a horizontal flow rate not less than 2.8 gallons per minute per foot (35 Liters per minute per meter).
- D. Design Criteria:
1. Compatibility:
 - a. Provide auxiliary materials recommended by the waterproofing manufacturer that are compatible with one another and with the waterproofing, as demonstrated by the waterproofing manufacturer based on testing and field experience.
 2. Product Data:
 - a. Submit Product Data for each type of product specified herein to the Program/Project Manager for approval.
 - 1) Include the manufacturer's written instructions for evaluating, preparing, and treating the substrate, technical data, and physical and performance properties tested for the waterproofing.
 3. Shop Drawings:
 - a. Prepare Shop Drawings for the cold fluid-applied waterproofing showing the locations and extent of the waterproofing.
 - 1) Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - b. Submit the Shop Drawings for the cold fluid-applied waterproofing to the Program/Project Manager for approval.
- E. Materials:
1. Acrylic-Based Elastomeric Waterproofing:
 - a. Provide 100 percent solvent-free, two-component, reactive acrylic-based cold liquid spray-applied seamless, elastomeric waterproofing complying with the requirements specified in ASTM C 836, and having properties complying with or exceeding the values specified in Table 07142-1.

Table 07142-1 Membrane Properties ⁽¹⁾		
Property	Test Method	Acceptable Values
Gel time	N/A	6 to 11 minutes
Cure time	N/A	30 minutes
Water vapor transmission	ASTM E 96/ E 96M, Method A	1.048 g/m ² /day



Table 07142-1 Membrane Properties ⁽¹⁾		
Property	Test Method	Acceptable Values
Adhesion to concrete	ASTM D 7234	100 psi (0.7MPa) with failure in concrete
Tensile strength		
Typical	ASTM D 638, Die C	1,700 psi (11.8MPa)
Heat ageing at 160 F (4 weeks)	ASTM D 638, Die C	0 percent change
Elongation at Break		
Typical	ASTM D 638, Die C	130 percent at break
Heat ageing at 160 F (4 weeks)	ASTM D 638, Die C	0 percent change
Low temperature flexibility	CAN/CGSB 37.50 M89	Pass 1/4 inch (6.5mm) mandrel at -13 F (-25 C)
For Railroads:		
Dynamic ballast impact test	SNCF 181kN for 2x10 ⁶ cycles	No damage or leak
1. Test laboratory-prepared samples at 68 degrees Fahrenheit (20 degrees Celsius); and where applicable, after a 24-hour cure.		

- b. Manufacturers:
 - 1) Stirling Lloyd Group Plc, Eliminator®, <http://www.stirlinglloyd.com>.
 - 2) Approved equal.
2. Primer:
 - a. Provide the waterproofing manufacturer's standard 100 percent solvent-free, reactive methyl methacrylate-based, two-component resin primer capable of a full cure in 40 minutes at 68 degrees Fahrenheit (20 degrees Celsius).
 - b. Manufacturers:
 - 1) Stirling Lloyd Group Plc, Eliminator®, <http://www.stirlinglloyd.com>.
 - 2) Approved equal.
3. Protection Course:
 - a. Cast-In-Place Concrete:
 - 1) Provide cast-in-place concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete.



2.02 ACCESSORIES

- A. Insulation:
 - 1. Provide insulation complying with the requirements specified in Section 07210, Building Insulation.
- B. Joint Sealants:
 - 1. Provide joint sealants complying with the requirements specified in Section 07920, Joint Sealants.
- C. Sheet Flashing:
 - 1. Provide sheet flashing complying with the requirements specified in Section 07620, Sheet Metal Flashing and Trim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine the substrates and conditions in the areas to receive cold fluid-applied waterproofing for compliance with specified requirements and other conditions affecting performance of the waterproofing.
 - 2. Verify that substrate concrete has cured and aged for the minimum time period recommended by the waterproofing manufacturer.
- B. Pre-Installation Testing:
 - 1. Tensile Bond Strength Test:
 - a. Conduct random tests to verify the substrate has adequate tensile bond strength
 - 1) Test Procedure:
 - a) Tests substrate tensile bond strength in accordance with the requirements specified in ASTM D 7234 at a minimum test frequency of 1 test for each 5000 square feet (500m²) of substrate.
 - b) For areas smaller than 5000 square feet (500m²), perform a minimum of 3 tests.
 - 2) Acceptance Criteria:
 - a) Tensile bond strengths of the primer to the substrate greater than or equal to 100 psi (0.7MPa), with failure in the concrete, indicate adequate surface preparation.
 - 2. Capillary Moisture Test:
 - a. Verify that the substrate is visibly dry and free of moisture.
 - 1) Test Procedure:



- a) Determine the capillary moisture in the substrate in accordance with the requirements for the plastic sheet method specified in ASTM D 4263.
 - 2) Acceptance Criteria:
 - a) The absence of moisture indicates appropriate surface conditions.
- C. Evaluation and Assessment:
- 1. Proceed to apply the cold fluid-applied waterproofing only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
- 1. Protect the Work of other trades, whether being coated or not, against damage from application of the waterproofing.
 - a. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.
 - b. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- B. Surface Preparation:
- 1. Prior to applying the waterproofing, clean and prepare the substrate in accordance with the waterproofing manufacturer's surface preparation recommendations.
 - a. Ensure the substrate where waterproofing will be applied is clean, dust-free, and dry.
 - b. Submit the waterproofing manufacturer's written surface preparation recommendations to the Program/Project Manager for information.
- C. Demolition/Removal:
- 1. Prior to applying the waterproofing, remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from the substrate concrete.
 - a. Abrasive blast clean the substrate concrete surfaces with a self-contained, re-circulating, blast-cleaning apparatus to uniformly expose the top surface of fine aggregate in accordance with the requirements specified in ASTM D 4259.
 - 1) Remove material to create a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, and form-release agents.
 - 2) Remove the remaining loose material, and clean the surfaces, in accordance with the requirements specified in ASTM D 4258.
 - 2. Remove fins, ridges, and other projections; and fill honeycomb, aggregate pockets, and other voids using appropriate concrete patching materials.



3.03 APPLICATION

- A. Apply waterproofing in accordance with the requirements specified in ASTM C 898 and with waterproofing manufacturer's application instructions.
 - 1. Apply primer over the prepared substrate.
 - 2. Submit the waterproofing manufacturer's written application instructions to the Program/Project manager for information.
- B. Unreinforced Waterproofing Applications:
 - 1. Mix the waterproofing materials, and apply the materials by spray, roller, notched squeegee, trowel, or another application method suitable for the substrate slope.
 - a. Spray-apply 2 different color-coded waterproofing coats to obtain a seamless membrane free of entrapped gases, and having an average dry film thickness of 120 mils and a minimum dry film thickness of 100 mils at any point.
 - 1) Ensure that each coat has a wet film thickness of 60 mils to achieve an overall coverage rate of 13.4 square feet per gallon.
 - 2) Verify the wet film thickness of the waterproofing after the application of every 100 square feet (9.3m²) of material.
 - b. Apply the waterproofing to prepared wall terminations and vertical surfaces.
- C. Reinforced Waterproofing Applications:
 - 1. Mix the waterproofing materials, and apply the materials by roller, notched squeegee, trowel, or another suitable application method.
 - a. Apply the first coat of waterproofing, embed the membrane-reinforcing fabric, and apply a second coat of waterproofing to completely saturate the reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases, and having an average dry film total thickness of 120 mils (3mm).
 - 1) Coordinate the total thickness of the waterproofing membrane with the weight of the membrane-reinforcing fabric and the type of waterproofing.
 - 1) Verify the wet film thickness of the waterproofing after the application of every 100 square feet (9.3m²) of material.
 - b. Apply the reinforced waterproofing to prepared wall terminations and vertical surfaces.
- D. Curing:
 - 1. Cure the waterproofing according to the manufacturer's written recommendations, taking care to prevent contamination and damage during the application stages and curing period.
- E. Protection Course:



1. Before starting subsequent construction operations, provide a cast-in-place concrete protection course having tooled joints over the cured membrane.

F. Special Techniques:

1. Where the membrane is to be joined to existing cured material and at day joints, ensure that the new application overlaps the existing one by at least 2 inches. No preparation shall be necessary unless the existing materials are contaminated with dirt in which case the repair/overlap shall first be wiped with solvent (e.g. acetone).
2. Terminations and Penetrations:
 - a. At terminations and penetrations through the waterproofing, and at expansion joints, drains, and sleeves, prepare the vertical and horizontal surfaces in accordance with the requirements specified in ASTM C 898 and with the waterproofing manufacturer's instructions.
 - b. Unless otherwise recommended by the waterproofing manufacturer, prime the substrate at terminations and penetrations.
 - c. At terminations and penetrations, apply 2 separate waterproofing applications.
 - 1) If recommended by the waterproofing manufacturer, embed a joint reinforcing strip in the first preparation coat.
 - 2) If recommended by the waterproofing manufacturer, provide sealant cants around penetrations and at the inside corners of deck-to-wall butt joints.
 - d. Submit the waterproofing manufacturer's written instructions for preparing vertical and horizontal surfaces at terminations and penetrations to the Program/Project Manager for information.
3. Joint and Crack Treatment:
 - a. Prior to applying the waterproofing, prepare, rout, treat, and fill joints and cracks in the substrates in accordance with the requirements specified in ASTM C 898, and with the waterproofing manufacturer's written joint and crack treatment instructions.
 - 1) Before coating surfaces with waterproofing, remove dust and dirt from the joints and cracks in accordance with the requirements specified in ASTM D 4258.
 - 2) Install joint sealants in accordance with the requirements specified in ASTM C 1193.
 - 3) Prime the substrate, and apply a single thickness of the preparation strip extending a minimum of 3 inches along each side of the joint.
 - a) Apply a bond breaker between joint sealants and the preparation strip.
 - b) Apply waterproofing in 2 separate applications, and embed a joint reinforcing strip in the first preparation coat.
 - 4) Unless expansion joint gaskets or expansion joint cover assemblies are present, and where indicated in the Contract



Documents or required according to the waterproofing manufacturer's written instructions, provide sheet flashing bonded to deck and wall substrates.

- a) Extend the sheet flashings onto perpendicular surfaces and other work penetrating the substrate in accordance with the requirements specified in ASTM C 898.

3.04 REPAIR/RESTORATION

- A. If an area of waterproofing is left untreated, or if the membrane becomes damaged, apply a patch repair to restore the integrity of the waterproofing system.
 1. Cut back the damaged area to sound material, and wipe the area with a solvent, such as acetone, to remove contaminants on the periphery up to a width of at least 2 inches.
 2. Prime the substrate as necessary, followed by the application of the membrane.
 3. Obtain a continuous layer over the substrate with a 2-inch overlap onto existing membrane.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when cold fluid-applied waterproofing is being applied, the Testing and Inspection Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Flood Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will observe flood testing and examine the underside of horizontal decks and terminations for evidence of leaks during the flood testing.
 - 2) After the waterproofing has been completed but before the overlaying construction is placed, each deck area will be flood tested for leaks in accordance with the recommended method specified in ASTM D 5957.



- 3) After temporary containment assemblies, plugs, or dam drains have been installed, the deck area will be flooded with potable water having an average depth of 2-1/2 inches, a minimum depth of 1 inch, and not exceeding a depth of 4 inches.
- 4) A clearance of 2 inches will be maintained from the top of sheet flashings.
- 5) Each area will be flooded for at least 24 hours, but for no longer than 72 hours.
- b. Acceptance Criteria:
 - 1) Areas not exhibiting leakage pass the Flood Test.
3. Inspections:
 - a. Have the manufacturer-qualified site representative inspect substrate conditions, surface preparation, and application of the membrane, flashings, protection, and drainage components.
- B. Non-Conforming Work
 1. After flood testing, repair leaks, repeat flood tests, and make further repairs until the waterproofing installation is watertight.
- C. Manufacturer Services:
 1. Engage a full time technical site representative qualified by the waterproofing membrane manufacturer to perform inspections, and to submit daily reports to the Program/Project Manager.
 2. Install waterproofing only in the presence of the manufacturer's technical site representative.

3.06 CLEANING

- A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by the manufacturer of the construction items affected.
- B. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect applied waterproofing from damage and wear during the remainder of the construction period.
 1. Do not permit foot or vehicular traffic on unprotected waterproofing membrane.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 07161

METAL OXIDE WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for metal-oxide waterproofing for negative-side application to concrete.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 - Cast-In-Place Concrete.
 - 5. Section 07920 - Joint Sealants.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CGSB – Canadian General Standards Board.
 - 2. SNCF – The French national railway.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 1193 – Standard Guide for Use of Joint Sealants.
 - b. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
 - c. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.
 - d. ASTM D 4259 – Standard Practice for Abrading Concrete.
 - e. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - f. ASTM D 5957 – Standard Guide for Flood Testing Horizontal Waterproofing Installations.
 - g. ASTM D 7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
 - h. ASTM E 96/ E 96M – Standard Test Methods for Water Vapor Transmission of Materials.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency and the City prior to incorporating items requiring testing by them into the Work.
- B. Pre-Installation Meetings:
 - 1. Conduct a Pre-installation Conference at the Site to review waterproofing requirements, including surface preparation, substrate conditions and pretreatment, minimum curing periods, forecasted weather conditions, special details and flashings, installation procedures, testing and inspection procedures, protection, and repairs.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Metal Oxide waterproofing.
 - 2) Patching compound.
 - 3) Plugging compound.
 - b. Shop Drawings:
 - 1) Metal Oxide waterproofing.
 - c. Mock-ups
 - 1) Metal Oxide waterproofing typical horizontal and vertical surfaces shown on drawings.
 - d. Qualification Statements:
 - 1) Metal Oxide waterproofing applicator or installer's qualifications.
 - 2) Product certificates
 - 3) Product Test reports.
 - 4) Field quality-control reports.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Metal Oxide Waterproofing.
 - 2) Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for metal-oxide waterproofing.



- b. Manufacturer's Instructions:
 - 1) Waterproofing manufacturer's written surface preparation recommendations.
 - 2) Waterproofing manufacturer's written instructions for preparing vertical and horizontal surfaces at terminations and penetrations.
 - 3) Waterproofing manufacturer's written application instructions.
 - c. Manufacturer's Reports:
 - 1) Daily reports from the technical site representative qualified by the waterproofing membrane manufacturer.
 - d. Qualification Data:
 - 1) Cold fluid-applied waterproofing applicator or installer's qualifications:
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Metal Oxide Waterproofing Materials Warranty.
 - 2) Waterproofing Installation Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Metal Oxide Waterproofing Installer's Qualifications:
 - a. Engage a firm that is experienced in applying metal oxide waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer, specified for this Contract.
 - b. Submit the cold fluid-applied waterproofing installer's qualifications to the Program/Project Manager for approval.
 - 1) Include a list of at least 5 references for similar projects in North America completed to the client's satisfaction during the past 5 years in a similar environment and application.
- C. Certifications:
- 1. Test and Evaluation Reports:



- a. Submit Test and Evaluation Reports for the waterproofing, proposed to be provided under this Section, to the Program/Project Manager for information.
 - 1) Furnish test and evaluation reports based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Mock-Ups:
 - 1. Before beginning to apply the waterproofing materials for production Work, at a location determined by the Program/Project Manager apply waterproofing to 100 square feet of deck and wall to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality to the Program/Project Manager.
 - a. Provide mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - b. If the Program/Project Manager determines the mockups do not comply with the specified requirements, reapply waterproofing until the mockups are approved by the Program/Project Manager.
 - c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in the mockups, unless the Program/Project Manager specifically approves such deviations in writing.
 - d. Mock-ups applied as part of the building or structure as opposed to those erected separately may become part of the completed Work if approved by the Program/Project Manager and undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver liquid materials to the Site in their original containers with seals unbroken, labeled with the manufacturer's name, the product brand name and the type, date of manufacture, shelf life, and directions for storing and mixing with other components.
- B. Storage and Handling Requirements:
 - 1. Store liquid materials in their original undamaged containers in a clean, dry, protected location, and within the temperature range required by the waterproofing manufacturer.
 - 2. Remove and replace liquid materials that cannot be applied within their stated shelf life.
 - 3. Protect stored materials from direct sunlight.
- C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Apply waterproofing within the range of ambient and substrate temperatures recommended by the waterproofing manufacturer.
 - a. Do not apply waterproofing to damp or wet substrate, when the relative humidity exceeds 85 percent, or when temperatures are less than 14 degrees Fahrenheit if the substrate temperature is above the dew point.
 - 1) Proceed with waterproofing work only if temperature is maintained at 40 deg F or above, during work and cure period, and space is well ventilated and kept free of water.
 - 2) If conditions are outside of these ranges, consult the manufacturer.
 - b. Do not apply waterproofing in snow, rain, fog, or mist; or when these weather conditions are imminent during an application or curing period.
2. Maintain adequate ventilation during application and curing of waterproofing materials.
3. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

1.08 WARRANTY

A. Manufacturer Warranty:

1. Warrant the metal oxide waterproofing materials against failures within the 5-year period after the Date of Substantial Completion:
 - a. Submit a Metal Oxide Waterproofing Materials Warranty on the manufacturer's standard or customized form, without monetary limitation, in which the manufacturer agrees to repair or replace waterproofing that fails to remain watertight within the specified warranty period to the Program/Project Manager for approval.
 - b. The Metal Oxide Waterproofing Materials Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to the specified requirements, or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

B. Special Warranty:

1. Special Installer's Warranty:



- a. Warrant the cold fluid-applied waterproofing workmanship against failures within the 5-year period after the Date of Substantial Completion:
 - 1) Include removing and reinstalling structure or substrate in the Warranty.
 - 2) Submit a Metal Oxide Waterproofing Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair waterproofing that fails to remain watertight within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 WATERPROOFING MATERIALS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain waterproofing materials, and accessories from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments and ICC International Building Code (IBC) as Amended by the City of Phoenix.
- C. Design Criteria:
 - 1. Compatibility:
 - a. Provide auxiliary materials recommended by the waterproofing manufacturer that are compatible with one another and with the waterproofing, as demonstrated by the waterproofing manufacturer based on testing and field experience.
 - 2. Product Data:
 - a. Submit Product Data for each type of product specified herein to the Program/Project Manager for approval.



- 1) Include the manufacturer's written instructions for evaluating, preparing, and treating the substrate, technical data, and physical and performance properties tested for the waterproofing.
3. Shop Drawings:
 - a. Prepare Shop Drawings for the metal oxide waterproofing showing the locations and extent of the waterproofing.
 - 1) Include details for substrate joints and cracks, flashing, penetrations, inside corners, tie-ins with other termination conditions.
 - b. Submit the Shop Drawings for the metal oxide waterproofing to the Program/Project Manager for approval.

D. Materials:

1. Metal Oxide Waterproofing Compound:
 - a. Provide a product specifically formulated for waterproofing concrete and masonry substrates; containing pulverized iron and a chemical oxidizing agent to cause the iron particles to rust and grow in size in the presence of water; with VOC content complying with limits of authorities having jurisdiction.
 - b. Manufacturers:
 - 1) Anti-Hydro International, Inc; A-H Metallic Waterproofing
 - 2) Metalcrete Industries; Metalcrete Waterproofing.
 - 3) Specco Industries, Inc.; Speccrete Metallic Waterproofer.
 - 4) Approved equal.

2.02 ACCESSORY MATERIALS

A. Patching Compound:

1. Provide factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections.
2. Compatible with substrate and other materials indicated
3. VOC content complying with limits of authorities having jurisdiction.

B. Plugging Compound:

1. Provide factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer.
2. Resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic)
3. Compatible with substrate and other materials indicated.
4. VOC content complying with limits of authorities having jurisdiction.

C. Portland Cement:

1. ASTM C 150, Type 1.



- D. Sand
 - 1. ASTM C 144.
- E. Water
 - 1. Potable.

2.03 MIXES

- A. Metal Oxide Waterproofing Compound
 - 1. Add metal oxide waterproofing components, pre-mixed or field mixed, per manufacturer's written instructions.
 - 2. Blend together with mechanical mixer or by hand to required consistency for reach coat.
- B. Protection Coating
 - 1. Field mix protection coat consisting of Portland cement and sand as recommended by same manufacturer as metal oxide waterproofing according to manufacturer's written instructions for application over waterproofing.
 - 2. Measure, batch, and mix materials with potable water.
 - 3. Blend together with mechanical mixer to required consistency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine the substrates and conditions in the areas to receive metal oxide waterproofing for compliance with specified requirements and other conditions affecting performance of the waterproofing.
 - 2. Verify that substrate concrete has cured and aged for the minimum time period recommended by the waterproofing manufacturer.
- B. Evaluation and Assessment:
 - 1. Proceed to apply the metal oxide waterproofing only after unsatisfactory conditions have been corrected.
 - 2. Notify Architect in writing of active leaks or defects that would affect system performance.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect the Work of other trades, whether being coated or not, against damage from application of the waterproofing.
 - a. Protect other work from damage caused by cleaning, preparation, and application of waterproofing.



- b. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.
- c. Provide temporary enclosure to ensure adequate ambient temperatures and ventilation conditions for application.
- d. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- e. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
- f. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.

B. Surface Preparation:

- 1. Prior to applying the waterproofing, clean and prepare the substrate in accordance with the waterproofing manufacturer's surface preparation recommendations.
 - a. Ensure the substrate where waterproofing will be applied is clean, dust-free, and dry.
 - b. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
 - 1) At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep.
 - 2) Fill reveal with patching compound flush with surface.
 - c. Submit the waterproofing manufacturer's written surface preparation recommendations to the Program/Project Manager for information.

C. Demolition/Removal:

- 1. Prior to applying the waterproofing, remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from the substrate concrete to ensure that waterproofing bonds to surface.
 - a. Clean concrete surfaces according to ASTM D 4258.
 - 1) Remove material to create a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, and form-release agents.
 - b. Mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
- 2. Remove fins, ridges, and other projections; and fill honeycomb, aggregate pockets, and other voids using appropriate concrete patching materials.

3.03 APPLICATION

- A. Apply waterproofing in accordance with the requirements of the waterproofing manufacturer's application instructions.



1. Submit the waterproofing manufacturer's written application instructions to the Program/Project manager for information.
2. As recommended by the manufacturer, saturate surface with water and maintain in a damp condition until applying waterproofing. Remove standing water.
3. Apply waterproofing to surfaces indicated on Drawings.
4. Number of Metal Oxide Coats: Three.

B. Curing:

1. Moist-cure the waterproofing after final coat has set, followed by air drying prior to being placed in service, unless otherwise recommended according to the manufacturer's written recommendations, taking care to prevent contamination and damage during the application stages and curing period; unless otherwise recommended in writing by manufacturer.

C. Application Method:

1. Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids.
2. Brush each subsequent coat into full contact with previous coat.
3. Dampen surface between coats.
4. Allow each coat to cure before applying subsequent coats.
5. Terminations and Penetrations:
 - a. At terminations and penetrations through the waterproofing, and at drains, and sleeves, prepare the vertical and horizontal surfaces in accordance with the requirements specified in ASTM C 898 and with the waterproofing manufacturer's instructions.
6. Protection Coat:
 - a. Apply to a thickness of 1/8 inch (3 mm) to 1/4 inch (6 mm) for walls and 1 inch for floors.
7. Waterproofing Treatment Extents: Extend waterproofing treatment as follows:
 - a. Onto columns integral with treated walls.
 - b. Onto interior non-treated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete.
 - c. Onto every substrate in areas indicated for treatment, including pits, sumps, and similar offsets and features.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.



2. During the period when metal oxide waterproofing is being applied, the Testing and Inspection Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

B. Non-Conforming Work

1. After flood testing, repair leaks, repeat flood tests, and make further repairs until the waterproofing installation is watertight.

3.05 CLEANING

- A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by the manufacturer of the construction items affected.
- B. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Protect applied waterproofing from damage and wear during the remainder of the construction period.
 1. Do not permit foot or vehicular traffic on unprotected waterproofing membrane.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	07/13/2018	N/A	All	First edition.





SECTION 07180

TRAFFIC COATINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for exterior pedestrian traffic coatings.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 07920 - Joint Sealants

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Attend a pre-installation meeting at the Site held in compliance with the requirements of Section 01316, Project Meetings, to discuss the requirements for applying the traffic coatings to be provided under this Contract.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Traffic Coating
 - 2) Primer
 - 3) Basecoat
 - 4) Intermediate coats
 - 5) Topcoat
 - 6) Bodycoat
 - 7) Aggregate
 - 8) Flakes
 - 9) Joint Sealants
 - 10) Sheet Flashing
 - 11) Adhesive
 - 12) Reinforcing Strip
 - b. Shop Drawings:
 - 1) Traffic coatings.



- c. Samples:
 - 1) Samples for each type of traffic coating and substrate indicated in Contract Documents
 - 2) Samples for each type of finish indicated in the Contract Documents.
 - d. Certificates:
 - 1) Traffic coating manufacturer's Certificate of Compliance.
 - e. Qualification Statements:
 - 1) Installer's Qualifications
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Source Quality Control Submittals:
 - 1) Material Test Reports.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Traffic Coating Materials Warranty.
 - 2) Traffic Coating Installation Warranty.

1.04 QUALITY ASSURANCE

- A. Qualifications:
- 1. Installer's Qualifications:
 - a. Retain an installer that is trained and approved for installation of traffic coatings.
- B. Site Samples:
- 1. Submit samples for each type of traffic coating required, prepared on rigid backing and of same thickness and material indicated in the Contract Documents to the Program/Project Manager for approval.
 - 2. Submit samples for each type of finish indicated in the Contract Documents to the Program/Project Manager for approval.
- C. Mock-Ups:
- 1. Apply mock-ups to set quality standards for materials and execution.
 - a. Apply each coating to at least 100 square feet of each substrate selected by the Program/Project Manager to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship. The 100 square feet mock-up area shall include an edge condition.



- b. Remove and reapply mock-ups until approved by Program/Project Manager.
- c. Approved mock-ups may become part of the completed work if undisturbed at time of Substantial Completion.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver traffic coating materials to the Site in their original containers, with their seals unbroken, labeled with the manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- B. Storage and Handling Requirements:
 - 1. To prevent deterioration from moisture or other detrimental effects, store materials in accordance with the manufacturer's written instructions.
- C. Packaging Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.06 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not proceed to apply traffic coatings unless the surface and air temperatures are within the traffic coating manufacturer's acceptable limits.
 - 2. Do not apply traffic coatings if standing water is visible on the surface to be treated, if the wind speed exceeds 15 miles per hour, or if rain is expected within 6 hours of the scheduled application time.

1.07 WARRANTY

- A. Manufacturer Warranty:
 - 1. Warrant the traffic coatings against defects in materials within the 5-year period after the Date of Substantial Completion:
 - a. The manufacturer's liability does not include variable factors out of the manufacturer's control, such as environmental conditions, application techniques, and surface conditions which are critical to the results obtained.
 - b. Submit a Traffic Coating Materials Warranty on the traffic coating manufacturer's standard or customized form, without monetary limitation, in which the traffic coating manufacturer agrees to replace properly applied traffic coatings that fail in materials within the specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.



B. Special Warranty:

1. Installer's Warranty:

- a. Warrant the traffic coatings workmanship against failures within the 5-year period after the Date of Substantial Completion:
 - 1) Submit a Traffic Coating Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair traffic coatings that fail within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 TRAFFIC COATING PRODUCT TYPES

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
- 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:

- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

C. Design Criteria:

1. Product Data:

- a. Obtain the traffic coating manufacturers' Product Data for each type of product proposed for the Work of this Section.
- b. Submit the traffic coating manufacturers' Product Data for each type of product to the Program/Project Manager for approval.
- 2. Submit Shop Drawings showing the extent of each traffic coating to the Program/Project Manager for approval.
 - a. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.

D. Materials

1. Traffic Coating:

- a. Provide a traffic coating complying with ASTM C 957, ASTM D2047 and ASTM D523.



- b. Provide primers; base, intermediate, and topcoats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- c. Manufacturers:
 - 1) Dex-O-Tex/Crossfield Products Corp.; Elastatex 500 Elastomeric Waterproofing.
 - 2) Dex-O-Tex/Crossfield Products Corp.; Weatherware waterproofing system at Stage 2, 24th Street Station
 - 3) Pecora Corporation; .Pecora-Deck 800
 - 4) Tamms Industries, Inc.; Tammsdeck System.
 - 5) ChemSystems, Inc.; Quartzite Seamless Polymer Topping System.
 - 6) Miracote; MiraGuard ColorBond XL / MiraGard HDWB body coat with micro-flake broadcast
- 2. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.
 - a. Provide MiraPrima Aqua-Blok XL if moisture content in newly placed cast-in-place concrete exceeds 4 pounds of moisture vapor transmission per 100 sf over a 24 hour period.
- 3. Basecoat for Miracote: Pigmented Basecoat Component: single component self-crosslinking acrylic finish waterproofing sealer
 - a. Color: Dolphin Gray
- 4. Basecoat Component for Miracote: water-based, waterproofing sealer, VOC compliant
 - a. Color: clear or matte clear
 - b. Coverage: one or two very thin coats (6-8 mils wet; 2-3 mils dry)
- 5. Basecoats for Weatherware: Barrier-Guard with fabric and slip sheet, and Neotex body coat
 - a. First basecoat: Barrier -guard with fabric and slip sheet
 - 1) Fluid-applied polymer emulsion waterproofing membrane
 - 2) Comply with ANSI 10-99.
 - b. Second Basecoat: Neotex body coat, single-component premixed material
- 6. Intermediate Coat for Weatherware:
 - a. Resistite, 2-component protective coating consisting of a dry mix powder blend and liquid polymer.
 - b. Color: As selected by Architect.
 - c. Coverage: minimum two coats to achieve the desired durability and finished appearance.
 - d. Finish: smooth or textured for slip resistance (greater than or equal to minimum coefficient of friction wet and dry code requirements)
- 7. Topcoat: Single- or multicomponent, aromatic liquid urethane elastomer with UV inhibitors.
 - a. Color: Gray or manufacturers standard color selection.



8. Topcoat for Quartzite: Two-part, water-based polyurethane that forms a high-solids coating, UV stable, non-yellowing.
 - a. Color: liquid, clear
9. Topcoat for Miracote: high-solids, two-component, UV-stable, aliphatic elastomeric polyaspartic resinous coating
 - a. Color: clear
 - b. Finish: high gloss and satin finishes
10. Topcoats for Weatherware: AJ-44 SR Topcoat, single component self-crosslinking solar-reflective acrylic sealer, UV stable
 - a. Color: Architect to select from standard colors
 - b. Second Topcoat: Weatherseal XL, water-based, waterproofing sealer, VOC compliant
 - 1) Apply over broadcast mica flakes
11. Body Coat for Quartzite: One-component, high strength polymer topping system, decorative aggregates.
 - a. Thickness: 1/16" – 1/8"
 - b. Finish: smooth or textured for slip resistance
 - c. Coverage rate: fine sand (32 sf/gal), medium sand (19 sf/gal), quartz aggregate (24 sf/gal).
12. Aggregate: Uniformly graded, washed silica sand of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.
 - a. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:
 - 1) Intermediate Coat: 8 to 10 lb/100 sq. ft.
 - 2) Topcoat: 8 to 10 lb/100 sq. ft.
13. Flake for Miracote: Microflake chips
 - a. Color: CF 01 – gray, white
14. Flake for Weatherware: Mica flakes
 - a. Color: Black
 - b. Chip Size: Standard 1/4"
 - c. Broadcast effect: Light sprinkle
 - d. Broadcast over AJ-44 topcoat
15. Miscellaneous Materials
 - a. Joint Sealants: As specified in Section 07920, Joint Sealants.
 - b. Sheet Flashing: Nonstaining.
 - 1) Minimum Thickness: 60 mils (1.5 mm).
 - 2) Material: Sheet material recommended in writing by traffic coating manufacturer .
 - 3) Sheet metal shall be degreased, prepared and primed prior to application of the membrane material.
 - 4) Install in accordance with SMACNA Standards.
 - c. Adhesive: Contact adhesive recommended in writing by traffic coating manufacturer.



- d. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of traffic coatings.
 - a. Notify Program/Project Manager of any defects or issues with installation of this product at this existing concrete deck.
 - b. Verify compatibility with and suitability of substrates.
 - c. Verify that substrates are visibly dry and free of moisture.
- B. Pre-Installation Testing
 1. Test for moisture vapor transmission by plastic sheet method according to ASTM D 4263.
 2. Test for moisture content by measuring with an electronic moisture meter or method approved by manufacturer.
- C. Evaluation and Assessment:
 1. Do not proceed installing the traffic coating until unsatisfactory conditions have been corrected.
 2. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage that could otherwise result from installation of the traffic coatings.
- B. Surface Preparation:
 1. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.
 2. Mask adjoining surfaces not receiving traffic coatings, to prevent spillage, leaking, and migration of coatings.
 3. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.
 - a. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 - b. Remove concrete fins, ridges, and other projections.
 - c. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.



- d. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.
- C. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.
- D. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
- E. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
- F. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.
- G. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

3.03 APPLICATION

- A. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.
 - 1. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft. (9 sq. m).
- B. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated recommended by manufacturer and omit aggregate on vertical surfaces.
- C. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.
- D. General Helix Quartzite Application: Apply each component of quartz-polymer flooring system according to manufacturer's directions to produce a uniform monolithic flooring surface of thickness indicated.
 - 1. Body Coat: Trowel or squeegee apply quartz-polymer material at nominal 1/8-inch thickness. When cured, sand or grind if necessary to remove trowel marks and roughness.
 - 2. Sealing Coats: After body coat has cured sufficiently, sealing coats of type recommended by flooring manufacturer to produce finish matching



approved sample and in number of coats and spreading rates recommended by manufacturer.

- E. General Miracote Application: Follow all manufacturer's directions, as published in their product technical data sheets and/or available installation guidelines regarding application of the microflake system.
1. Miracote Basecoat: Mix pigmented and clear basecoat components at a 1:1 ratio. Apply with roller at a rate of approximately 250 square feet per mixed gallon.
 2. Miracote Microflake broadcast: While basecoat is still wet, broadcast microflake chips into the wet material until refusal. After the basecoat has fully cured, remove all excess microflake chips.
 3. Clear receiving coat: Apply clear basecoat component over first coat of microflake chips at approximately 200 square feet per gallon.
 4. Second microflake broadcast: While clear receiving coat is still wet, broadcast microflake chips into the wet material until refusal. After the clear receiving coat has fully cured, remove all excess microflake chips.
 5. Sealing: Apply one coat of clear polyaspartic sealer at a rate of approximately 200 square feet per gallon.

3.04 CLEANING

- A. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.05 PROTECTION

- A. Protect traffic coatings from damage and wear during remainder of construction period.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition
1	03/12/2018	N/A	1.03.A, 2.01.D, 3.03.D	Add floor coating information
2	09/21/2018	N/A	2.01D.1.c.2), 2.01.D.5, 6, 10, & 14 2.01.D.15.b.3) & 4)	Add traffic coating information





SECTION 07190

WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for penetrating water-repellent treatments for the following vertical and horizontal surfaces:
 - a. Cast-in-place concrete.
 - b. Precast concrete.
 - c. Cast stone.
 - d. Concrete unit masonry.
 - e. Clay brick masonry.
 - f. Natural stone.
 - g. Portland cement plaster (stucco).
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. pH: A measure of the acidity or basicity of a solution, and defined as the cologarithm of the activity of dissolved hydrogen ions (H^+).



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Attend a pre-installation meeting at the Site held in compliance with the requirements of Section 01316, Project Meetings, to discuss the requirements for applying the water repellents to be provided under this Contract.
- B. Sequencing:
 - 1. Mortar Joints:
 - a. Do not apply water repellent until the pointing for mortar joints adjacent to the surfaces to receive water-repellent treatment has been installed and cured.
 - 2. Sealant Joints:
 - a. Do not apply water repellent until the sealants for joints adjacent to the surfaces to receive water-repellent treatment have been installed and cured.
 - 1) Water-repellent work may precede the sealant application only if the sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required for the Work of this Section.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Low volatile organic compound (VOC) silane penetrating water repellents.
 - 2) High volatile organic compound (VOC) silane penetrating water repellents.
 - 3) Low volatile organic compound (VOC) siloxane penetrating water repellents.
 - 4) High volatile organic compound (VOC) siloxane penetrating water repellents.
 - 5) Low volatile organic compound (VOC) silane/siloxane-blend penetrating water repellents.
 - 6) High volatile organic compound (VOC) silane/siloxane-blend penetrating water repellents.
 - b. Samples:
 - 1) Samples for each type of water repellent and substrate indicated in the Contract Documents.
 - c. Certificates:
 - 1) Water repellent manufacturers' Certificates of Compliance.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Results of the pre-installation surface testing, and recommendations resulting from an analysis of the test results.
 - b. Manufacturer's Instructions:
 - 1) Water repellent manufacturer's written pre-installation surface testing methods and instructions.
 - 2) Water repellent manufacturer's written surface preparation instructions.
 - 3) Water repellent manufacturer's written cleaning instructions.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any water repellent applied to interior surfaces.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Water Repellant Materials Warranty.
 - 2) Water Repellant Installation Warranty.

1.05 QUALITY ASSURANCE

A. Certifications:

1. Certificates of Compliance:
 - a. Submit the water repellent manufacturers' Certificates of Compliance, signed by the manufacturers, certifying that their products comply with the specified requirements to the Program/Project Manager for approval.

B. Site Samples:

1. Submit Samples for each type of water repellent and substrate indicated in the Contract Documents to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver water repellent materials to the Site in their original containers, with their seals unbroken, labeled with the manufacturer's name, product brand name and type, date of manufacture, and directions for storage.



- B. Storage and Handling Requirements:
 - 1. To prevent deterioration from moisture or other detrimental effects, store materials in accordance with the manufacturer's written instructions.
- C. Packaging Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not proceed to apply water repellants unless the surface and air temperatures are within the water repellant manufacturer's acceptable limits.
 - 2. Do not apply water repellants if standing water is visible on the surface to be treated, if the wind speed exceeds 15 miles per hour, or if rain is expected within 6 hours of the scheduled application time.

1.08 WARRANTY

- A. Manufacturer Warranty:
 - 1. Warrant the water repellants against defects in materials within the 5-year period after the Date of Substantial Completion:
 - a. The manufacturer's liability does not include variable factors out of the manufacturer's control, such as environmental conditions, application techniques, and surface conditions which are critical to the results obtained.
 - b. Submit a Water Repellant Materials Warranty on the water repellant manufacturer's standard or customized form, without monetary limitation, in which the water repellant manufacturer agrees to replace properly applied water repellants that fail in materials within the specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.
- B. Special Warranty:
 - 1. Installer's Warranty:
 - a. Warrant the water repellants workmanship against failures within the 5-year period after the Date of Substantial Completion:
 - 1) Submit a Water Repellant Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair water repellants that fail within the specified warranty period to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 WATER REPELLENT PRODUCT TYPES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
 - a. Low Emitting Materials – Paints and Coatings
 - 1) Provide Water Repellents with a VOC content of 100 g/L or less.
- C. Performance:
 - 1. Provide water repellants that cause concrete, masonry, and many natural stones to become repellant to water, chloride, waterborne contaminants, and weathering elements; and that prevent premature deterioration of the protected structures.
 - 2. Provide water repellants that permit water vapor transmittance.
- D. Design Criteria:
 - 1. Product Data:
 - a. Obtain the water repellent manufacturers' Product Data for each type of product proposed for the Work of this Section.
 - b. Submit the water repellent manufacturers' Product Data for each type of product to the Program/Project Manager for approval.
- E. Materials:
 - 1. Low Volatile Organic Compound (VOC) Silane Penetrating Water Repellents:
 - a. Provide a clear penetrating water repellent containing 20 percent or more solids of alkyltrialkoxysilanes in an alcohol, mineral spirits, water, or other proprietary solvent carrier; and having 100 grams per liter or less of volatile organic compounds (VOCs).
 - b. Manufacturers:



- 1) Dayton Superior Corporation; Weather Worker J-29-WB, www.daysup.com.
 - 2) Pecora Corporation, KlereSeal 940-S VOC, www.pecora.com.
 - 3) PROSOCO, Inc., SL100, www.prosoco.com.
 - 4) Tamms Industries, Inc., The Euclid Chemical Company, Barcade Silane 100, www.tamms.com.
 - 5) Tnemec Inc., Dur A Pell 40, www.tnemec.com.
 - 6) Approved equal.
2. Low Volatile Organic Compound (VOC) Siloxane Penetrating Water Repellent:
- a. Provide a clear penetrating water repellent containing 10 percent or more solids of oligomeric alkylalkoxysiloxanes in an alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and having 100 grams per liter or less of volatile organic compounds (VOCs).
 - b. Manufacturers:
 - 1) Dayton Superior Corporation, Weather Worker WB (J-26-WB), www.daysup.com.
 - 2) The Euclid Chemical Company, an RPM company, Euco-Guard VOX, <http://www.euclidchemical.com/>.
 - 3) H&C Concrete Care Products, The Sherwin-Williams Company, H&C Super V, <http://www.sherwin-williams.com/>.
 - 4) Rainguard International, MicroSeal, <http://www.rainguard.com/>.
 - 5) Tamms Industries, Inc., The Euclid Chemical Company, Barcade M.E., www.tamms.com.
 - 6) Approved equal.
3. Low Volatile Organic Compound (VOC) Silane/Siloxane-Blend Penetrating Water Repellent:
- a. Provide a clear penetrating water repellent consisting of a silane and siloxane blend having 100 grams per liter or less of volatile organic compounds (VOCs).
 - b. Manufacturers:
 - 1) L&M Construction Chemicals, Inc., Aquapel, <http://www.lmcc.com/>.
 - 2) Pecora Corporation, KlereSeal 910-W, <http://www.pecora.com/>.
 - 3) PROSOCO, Inc., Saltguard WB, www.prosoco.com.
 - 4) Tamms Industries, Inc., The Euclid Chemical Company, Barcade WB 244, www.tamms.com.
 - 5) Tnemec Inc., Dur A Pell 10, www.tnemec.com.
 - 6) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:



1. With the water repellent applicator present, examine the substrates, areas, and conditions where the water repellent will be applied for compliance with requirements and conditions affecting performance of this Work.
 - a. Verify that the surfaces are clean and dry in accordance with the water-repellent manufacturer's requirements.
 - b. Inspect the substrates for previously applied treatments that may inhibit penetration or performance of water repellents.
 - c. Verify that there is no efflorescence or other removable residues that would be trapped beneath the water repellent application.
 - d. Verify that required repairs are complete, cured, and dry before applying water repellent.
 - 1) Verify that joint sealers, paints, and glazing compounds and sealants are fully cured.

B. Pre-Installation Testing:

1. Check the moisture content of the surfaces in representative locations using methods recommended by the water repellent manufacturer.
2. Test the pH level of the surfaces in representative locations in accordance with the water-repellent manufacturer's written instructions to ensure a proper chemical bond to silica-containing or siliceous minerals.
3. Submit the water repellent manufacturer's written pre-installation surface testing methods and instructions, and the results of the pre-installation surface testing and recommendations resulting from an analysis of the test results, to the Program/Project Manager for information.

C. Evaluation and Assessment:

1. Proceed to apply the water repellent only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from application of the water repellent.
 - a. Mask windows, glass, metals, shrubs, and other vulnerable items from overspray.
 - b. Close air intakes, windows, and other openings.

B. Surface Preparation:

1. Cleaning:
 - a. To remove substances that could impair the penetration or performance of the water repellent product, clean the substrate in accordance with the water repellent manufacturer's surface preparation instructions before applying the water repellent.
 - b. Submit the water repellent manufacturer's written surface preparation instructions to the Program/Project Manager for information.



2. Walls:
 - a. Where water repellant is to be applied to walls, prevent water from entering through the backside or the top of walls.
 - 1) If possible, do not apply water repellants before the coping, flashing, and roofing have been installed; water trapped in the walls has drained out; and the building materials have dried.

3.03 APPLICATION

- A. Unless otherwise indicated in the Contract Documents, apply the water repellant in accordance with the application procedure specified in the water repellant manufacturer's instructions.
 1. Using low-pressure spray in uniform passes, apply a heavy-saturation coating of water repellant on the surfaces indicated in the Contract Documents to receive the treatment.
 2. Remove excess water repellant material.
 - a. Do not allow water repellant material to puddle beyond a saturation condition.
 3. Submit the water repellant manufacturer's written instructions specifying the application procedure to the Program/Project Manager for information.
- B. Apply a second saturation coating, repeating the procedure used for the first application.
 1. Comply with water repellant manufacturer's limitations regarding drying time between coats, and after-rainstorm-wetting of surfaces between coats.
- C. Special Techniques:
 1. If the water repellant manufacturer's written instructions are not applicable to the Contract conditions, consult with the water repellant manufacturer's technical representative.
 2. Precast Concrete and Cast Stone:
 - a. At Contractor's option, the first application of water repellant on precast concrete and cast stone units may be completed before installing them.
 - b. Mask mortar and sealant bond surfaces to prevent water repellant from migrating onto joint surfaces.

3.04 REPAIR/RESTORATION

- A. Correct damage to other Work caused by the application of the water-repellents.

3.05 SITE QUALITY CONTROL

- A. Manufacturer Services:



1. Engage a factory-authorized service representative to inspect the substrate before the application of the water repellents, and to instruct the applicator regarding the product and the application method to be used.

3.06 CLEANING

- A. Immediately clean water repellent from adjoining surfaces, and from surfaces soiled or damaged by the application of water repellents, as the Work of this Section progresses.
 1. Clean the water repellent from the surfaces in accordance with the water repellent manufacturer's cleaning instructions.
 - a. Submit the water repellent manufacturer's written cleaning instructions to the Program/Project Manager for information.
- B. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 2. Remove unused water repellants, residues, rinse water, wastes, and effluents in accordance with environmental regulations.

3.07 PROTECTION

- A. Do not allow traffic on the water repellants applied onto horizontal surfaces for the time period specified by the water repellent manufacturer.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.04.B.2, 2.01.B.3	Add requirements for ENVISION Sustainability Rating System



SECTION 07210

BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Requirements for building insulation, including the following types:
 - a. Batt insulation.
 - b. ~~Expanding foam insulation.~~
 - c. Fire safing insulation.
 - d. ~~Loose fill insulation.~~
 - e. Sprayed thermal and acoustical insulation.
 - f. Rigid insulation.
- B. Related Requirements:
1. Section 01330 - Submittal Procedures.
 2. Section 01360 - Sustainable Design Requirements.

Building Insulation
at the Stations



1.02 REFERENCES

- A. Abbreviations and Acronyms:
1. EPA: the United States Environmental Protection Agency.
 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 3. NRC: Noise reduction coefficient.
 4. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 5. UL: Underwriters Laboratories, Inc.
 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.



2. British Thermal Unit or Btu: A measure of energy defined as the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
3. Thermal Resistance, R: The mean temperature difference between 2 defined surfaces of material or construction under steady state conditions that induces a unit heat flux.
 - a. Thermal resistivity is expressed by the temperature difference in degrees Fahrenheit between the two exposed faces required to cause one Btu to flow through one square foot per hour at the mean temperatures indicated ($\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$).
 - b. Where the thermal resistivity of insulation products is designated by “R-values”, it represents the reciprocal of thermal conductivity (k-values).
4. Thermal Conductivity, k: The rate of heat flow through a homogenous material exactly 1-inch thick.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM C 203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
 - b. ASTM C 209 - Standard Test Methods for Cellulosic Fiber Insulation Board.
 - c. ASTM C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - d. ASTM C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - e. ASTM C 612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - f. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - g. ASTM C 739 - Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.
 - h. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - i. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
 - j. ASTM D 1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - k. ASTM D 1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - l. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - m. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.



- n. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- o. ASTM E 136 - Standard Test Method for Behavior of materials in a Vertical Tube Furnace at 750° C.
- p. ASTM E 605 – Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
- q. ASTM E 736 – Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
- r. ASTM E 759 – Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
- s. ASTM E 1042 – Standard Classification for Acoustically Absorptive Materials Applied by Trowel or Spray.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. FM Approvals LLC (FM):
 - a. FM Class Number 4470 – Approval Standard for Class 1 Roof Covers.
 - b. The Approval Guide, www.approvalguide.com.
4. Green Seal, Inc. (GS):
 - a. GC-03 - Green Seal™ Environmental Criteria for Anti-Corrosive Paints.
 - b. GS-11 – Green Seal™ Environmental Standard for Paints and Coatings.
5. Gypsum Association (GA):
 - a. GA-600 - Fire Resistance Design Manual.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. International Organization for Standardization (ISO):
 - a. ISO 9001 – Quality Management System – Requirements.
8. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1113 – Architectural Coatings.
 - b. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
9. Underwriters Laboratories, Inc. (UL):
 - a. UL Qualification Tests and Follow-Up Service Requirements.
 - b. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - c. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
10. United States Government:
 - a. United States Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. United States Department of Housing and Urban Development (HUD):



- 1) HUD UMB-80 – Use of Materials Bulletin No. 80 Spray Applied Cellulosic Thermal Insulation.
11. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate installation of the roofing system components with installation of the roofing insulation so the insulation is not exposed to precipitation or left exposed at the end of the workday.
 2. Coordinate application of the sprayed thermal and acoustical insulation with the other work in the area of application.
- B. Sequencing:
 1. Prior to applying sprayed thermal and acoustical insulation in an area, install roof penetrations.
 2. Prior to applying sprayed thermal and acoustical insulation in an area, install clips, hangers, supports, sleeves, and other attachments to the spray bases.
 3. In areas where sprayed thermal and acoustical insulation is to be applied, do not install ducts, piping, conduit, and other suspended equipment until after the sprayed thermal and acoustical insulation has been applied in the area.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Unfaced mineral-fiber blanket insulation.
 - 2) Faced mineral-fiber blanket insulation.
 - 3) Unfaced mineral fiber safing insulation.
 - 4) Sealant approved by the safing insulation manufacturer.
 - 5) Expanding foam insulation.
 - 6) Loose-fill insulation.
 - 7) Sprayed thermal and acoustical insulation.
 - 8) Rigid thermal insulation.
 - b. Qualification Statements:
 - 1) Sprayed thermal and acoustical insulation manufacturer's qualifications.
 - 2) Sprayed thermal and acoustical insulation applicator's qualifications.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Insulation manufacturer's written handling and installation instructions.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.
 - d. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coating within the buildings weather barrier.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Sprayed Thermal and Acoustical Insulation Manufacturer's Qualifications:
 - a. Unless accepted otherwise by the Program/Project Manager, obtain sprayed thermal and acoustical insulation products from manufacturers that employ a Quality Management System complying with the program described in ISO 9001, or a similar system.



- b. Submit proof of the sprayed thermal and acoustical insulation manufacturer's qualifications, including a copy of the manufacturer's ISO 9001 certification, to the Program/Project Manager for approval.
 - 2. Sprayed Thermal and Acoustical Insulation Applicator's Qualifications:
 - a. Engage a qualified firm that is approved, authorized, and/or licensed by the sprayed thermal and acoustical insulation manufacturer to apply the manufacturer's product.
 - b. Submit the sprayed thermal and acoustical insulation applicator's qualifications to the Program/Project Manager for approval.
 - C. Certifications:
 - 1. Manufacturer's Certificates of Compliance:
 - a. Sprayed Thermal and Acoustical Insulation:
 - 1) Submit the sprayed thermal and acoustical insulation manufacturer's Certificates of Compliance, certifying that the sprayed thermal and acoustical insulation being provided comply with the specified requirements, to the Program/Project Manager for approval.
 - a) Certify that the sprayed thermal and acoustical insulation contains no asbestos, fiberglass, or other man-made mineral fibers
 - b) Include evidence of complete sprayed thermal and acoustical insulation compliance with the specified performance requirements.
 - 2. Testing and Inspection Agency Certifications:
 - a. Sprayed Thermal and Acoustical Insulation:
 - 1) Provide sprayed thermal and acoustical insulation manufactured by a firm that subscribes to the certification and follow-up inspection services provided by independent testing agencies acceptable to the Authorities Having Jurisdiction (AHJ), such as the appropriate FM Approvals LLC (FM) program and/or UL Qualification Tests and Follow-Up Service Requirements.
 - a) Provide products marked with their intended use or classification for the location where the product is applied and the application intended.
 - b) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - (1) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - D. Mock-Ups:
 - 1. Sprayed Thermal and Acoustical Insulation Mock-Up:



- a. Construct a mock-up consisting of a representative sample of each type of sprayed thermal and acoustical insulation proposed for use applied to an area of 100 square feet.
- b. Obtain the Program/Project Manager's approval of the sprayed thermal and acoustical insulation mock-ups prior to providing these types of insulation for the production Work of this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver insulation materials in their original, unopened containers bearing the name of the manufacturer, product identification, and reference to third party testing, such as testing by FM Approvals LLC (FM) or Underwriters Laboratories, Inc. (UL).
- B. Storage and Handling Requirements:
 1. Store insulation materials inside under cover, off the ground, and in a dry location.
 - a. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources.
 2. Protect liquid adhesive from freezing.
 3. Comply with the insulation material manufacturer's written instructions for handling, storing, and protecting the material during installation.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 BUILDING INSULATION PRODUCT TYPES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain each type of building insulation from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.



B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

2. Sustainability Requirements:

a. Recycled Content

- 1) Provide glass fiber insulation with combined post-consumer recycled content and one-half pre-consumer recycled content that is no less than 25 percent.
- 2) Provide Fire-safing insulation with a minimum 85% pre-consumer content.

b. Low Emitting Materials – Paints and Coatings

- 1) Provide Architectural Non-Porous Sealant Primers with not more than 250 grams per Liter less water.
- 2) Provide architectural Porous Sealant Primers with not more than 775 grams per Liter less water.

c. All batt insulation shall be formaldehyde free.

C. Performance:

1. Fire-Test-Response Characteristics:

- a. Except for loose-fill thermal insulation, provide insulation and related materials that have the fire-test-response characteristics indicated for each material in Paragraph 2.01.E as determined when Underwriters Laboratories, Inc. (UL) or another testing and inspecting agency acceptable to the Authorities Having Jurisdiction tests identical products in accordance with the following test methods:

- 1) Surface-Burning Characteristics: ASTM E 84 or UL 723.
- 2) Fire-Resistance Ratings: ASTM E 119.
- 3) Combustion Characteristics: ASTM E 136.

- b. Identify materials with appropriate markings of the applicable testing and inspecting agency.

2. Thermal Resistance (R):

- a. Provide insulation that furnishes the following thermal resistances for the applications listed, unless otherwise indicated in the Contract Documents:

- 1) Roofs: R-30.
- 2) Walls: R-19.
- 3) Floors: R-19.

D. Design Criteria:

1. Provide insulating materials that comply with the requirements specified herein, and with the requirements of the standards referenced.



2. Provide materials that ensure continuity of the thermal barrier at building enclosure elements.
3. Preformed Units:
 - a. Provide preformed unit sizes selected from the manufacturer's standard thicknesses, widths, and lengths; and designed to fit the applications indicated.

E. Materials

1. General Building Insulating Materials:
 - a. For roofing insulation materials, refer to the associated roofing specification Sections.
 - b. Unfaced Blanket Insulation:
 - 1) Provide unfaced mineral-fiber blanket insulation consisting of fibers manufactured from glass, and complying with the requirements for Type I (blankets without membrane facing) as specified in ASTM C 665.
 - 2) Fire-Test-Response Characteristics:
 - a) Maximum flame-spread index: 25.
 - b) Maximum smoke-developed index: 50.
 - c) Combustion characteristics:
 - (1) Provide unfaced mineral-fiber blanket insulation passing the testing specified in ASTM E 136 for combustion characteristics
 - 3) Manufacturers:
 - a) CertainTeed Corporation, www.certainteed.com.
 - b) Johns Manville, www.jm.com/insulation/.
 - c) Owens Corning, www.owenscorning.com.
 - d) Approved equal.
 - c. Faced Blanket Insulation:
 - 1) Provide faced mineral-fiber blanket insulation consisting of fibers manufactured from glass with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on one face, and complying with the requirements for Type III (blankets with reflective facings), Class A (facing with a flame spread index of 25 or less); Category 1 (facing is a vapor retarder) as specified in ASTM C 665.
 - 2) Manufacturers:
 - a) CertainTeed Corporation, www.certainteed.com.
 - b) Johns Manville, www.jm.com/insulation/.
 - c) Owens Corning, www.owenscorning.com.
 - d) Approved equal.
 - d. Expanding Foam Insulation:
 - 1) Provide a closed-cell polyurethane system using an EPA-approved, zero ozone-depleting blowing agent capable of controlling air and moisture infiltration and of providing superior insulation performance.



- a) Fire-Test-Response Characteristics:
 - (1) Maximum flame-spread index: 25.
 - (2) Maximum smoke-developed index: 350.
- b) Thermal Conductivity:
 - (1) Minimum R Value: 6 per inch when measured in accordance with ASTM C 518.
- c) Water Vapor Transmission: 1.82 perms when measured in accordance with ASTM E 96/E 96M.
- 2) Manufacturers:
 - a) C.P. Chemical Co., Tripolymer, www.tripolymer.com.
 - b) Nordic Builders, Air Krete, <http://yp.eastvalleytribune.com>.
 - c) Tailored Chemical Products, Core-Fill 500, www.tailoredchemical.com.
 - d) BASF Polyurethane Foam Enterprises LLC, www.basf-pfe.com
 - e) NCFI Polyurethanes, www.ncfi.com.
 - f) Polyfoam Products, Inc., www.polyfoam.cc.
 - g) Approved equal.
- e. Loose-Fill Insulation:
 - 1) Provide self-supporting, cellulosic fiber loose-fill thermal insulation complying with the requirements specified in ASTM C 739, and suitable for being pneumatically placed and poured into wall spaces, and poured into joist spaces, through access holes.
 - 2) Provide loose-fill thermal insulation having the following properties:
 - a) Thermal Conductivity: 0.27 Btu-inches per hour-square foot-degree Fahrenheit.
 - b) Total Thermal Resistance: 19.0 hour-square-foot-degree Fahrenheit per British thermal unit.
 - 3) Ventilation Baffles:
 - a) Provide formed plastic ventilation baffles.
 - 4) Manufacturers:
 - a) GreenFiber, www.cocooninsulation.com.
 - b) Approved equal.
- f. Sprayed Thermal and Acoustical Insulation:
 - 1) Provide cellulosic acoustical and thermal insulation classified as Type II, Class (a) in accordance with the classification system defined in ASTM E 1042; containing no asbestos, fiberglass, or other man-made mineral fibers; suitable for spray application; and complying with the following additional requirements:
 - a) Bond Deflection:
 - (1) Provide sprayed acoustical and thermal insulation exhibiting no spalling or delamination when subjected to a 6-inch deflection in a 10-foot clear span in accordance with the requirements specified in ASTM E 759.



- b) Bond Strength:
 - (1) Provide sprayed acoustical and thermal insulation having a cohesive/adhesive force or bond strength of 100 pounds-force per square foot when tested in accordance with the Field Test Method specified in ASTM E 736.
- c) Color:
 - (1) Provide sprayed acoustical and thermal insulation having the color indicated on the Contract Drawings.
 - (a) If no color is indicated on the Contract Drawings, provide the colors selected by the Program/Project Manager from the manufacturer's standard color samples.
- d) Corrosiveness:
 - (1) Provide sprayed acoustical and thermal insulation determined by testing in accordance with the Test Procedures for Corrosiveness specified in HUD UMB-80 to be non-corrosive.
- e) Fire-Test-Response Characteristics:
 - (1) Provide sprayed acoustical and thermal insulation having the following fire-test-response characteristics:
 - (a) Maximum flame-spread index: 5.
 - (b) Maximum smoke-developed index: 5.
- f) Thickness:
 - (1) Provide sprayed acoustical and thermal insulation having at least the thicknesses indicated in Table 07210-1 to achieve the Noise Reduction Coefficient (NRC) indicated in the Contract Documents.

Table 07210-1 Thicknesses and Noise Reduction Coefficients (NRC) ⁽¹⁾								
Substrate	Insulation Thickness (Inches)	Sound Frequency (Hertz)						NRC Rating
		125	250	500	1000	2000	4000	
Solid Backing	1.00	0.08	0.29	0.75	0.98	0.93	0.96	0.75
	1.00 ⁽²⁾	0.47	0.90	1.10	1.03	1.05	1.03	1.00
	2.00	0.26	0.68	1.05	1.10	1.03	0.98	0.95
	3.00	0.57	0.99	1.04	1.03	1.00	1.00	1.00
1.5-Inch Ribbed Metal Deck	1.50	0.36	0.89	1.26	1.07	1.01	1.00	1.05
	3.00	0.97	1.04	1.13	0.99	0.95	0.98	1.05
1. Test material in accordance with the requirements specified in ASTM C 423. Some values in Table 07210-1 are interpolated.								
2. On lath.								



- (2) Provide sprayed acoustical and thermal insulation having the capability to provide R-values of 3.8 per inch up to R-19 determined in accordance with the requirements specified in ASTM C 518, and provide at least the thicknesses required to have the thermal resistance, R, specified.
- 2) Manufacturers:
 - a) International Cellulose Corporation, K-13 Spray-On System, <http://www.spray-on.com>.
 - b) Approved equal.
- g. Rigid Thermal Insulation:
 - 1) Provide rigid thermal insulation complying with the requirements for Type I, Class 1 faced rigid cellular polyisocyanurate thermal insulation board specified in ASTM C 1289; and consisting of a high-insulating value, closed-cell polyisocyanurate foam core sandwiched between durable exterior facers.
 - a) For one of the facers, provide a continuous sheet of aluminum foil.
 - b) For the other facer, provide a three-ply laminate consisting of kraft having aluminum foil on both sides.
 - 2) Provide rigid thermal insulation having the physical properties and R-values specified in Table 07210-2 and Table 07210-3.

Table 07210-2 Rigid Thermal Insulation Physical Properties

Property	Test Method	Value
Compressive strength ⁽¹⁾	ASTM D 1621	25.0 psi (minimum)
Flexural strength	ASTM C 203	55 psi ⁽²⁾ (minimum)
Water adsorption	ASTM C 209	0.05 percent by volume (maximum)
Water vapor permeance	ASTM E 96/E 96M ⁽³⁾	Less than 0.03 perms
Nominal density	ASTM D 1622	2 pounds per cubic foot
Operational temperature range	N/A	-50° to 190° Fahrenheit
1. Vertical compressive strength measured at 10 percent deformation or at yield, whichever comes first. 2. Based on 1 inch foam core. 3. Based on 1 inch thickness using the dessicant method.		

**Table 07210-3 Rigid Thermal Insulation R-Values**

Nominal Foam Thickness (Inches)	R-Value for Insulation Alone⁽¹⁾	R-Value for Insulation Plus 3/4-Inch Air Space⁽²⁾
3/8	2.0	N/A
1/2	3.3	6.1
5/8	4.1	6.9
3/4	5.0	7.8
1	6.5	9.3
<p>1. R-values determined on a full-sized product in accordance with the methods specified in ASTM C 518, ASTM C 1289, and ASTM C 1363 at a mean temperature of 75 degrees Fahrenheit.</p> <p>2. R-values determined by summing the R-value for insulation alone with an additional R-value calculated when an aluminum foil surface is installed next to a non-ventilated 3/4-inch air space (R = 2.8).</p>		

- 3) Manufacturers:
 - a) Dowel Chemical Company, Tuff-R™ Polyisocyanurate Insulation, <http://www.dow.com>.
 - b) Approved equal.
2. Safing Insulating Materials:
 - a. Unfaced Safing Insulation:
 - 1) Provide unfaced mineral fiber safing insulation complying with the requirements for Type I (blankets without facing) as specified in ASTM C 665, and with the requirements for Category 1 (no compressive resistance properties are required) or Category 2 (minimum compressive resistance properties are required) as specified in ASTM C 612.
 - a) Nominal Density: 4.0 pounds per cubic foot.
 - 2) Provide sealant approved by the safing insulation manufacturer for the conditions indicated on the Contract Drawings.
 - 3) Manufacturers:
 - a) USG Interiors, Inc., Thermafiber Safing Insulation, www.usg.com.
 - b) Owens Corning, www.owenscorning.com.
 - c) Approved equal.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine the substrates and Site conditions for compliance with the requirements of the Sections in which the substrates and related work are specified, and for other Site conditions affecting performance of the building insulation.
 - 2. Loose-Fill Insulation:
 - a. Where loose-fill thermal insulation is to be installed, verify that the substrate, adjacent materials, and the insulation are dry and ready to receive the insulation.
 - b. Verify that light fixtures in areas where loose-fill thermal insulation is to be installed have thermal cut-out devices to restrict over-heating in soffit or ceiling spaces.
 - c. Verify that the spaces where loose-fill thermal insulation is to be installed are unobstructed to allow insulation to be placed into the full space.
 - 3. Sprayed Thermal and Acoustical Insulation:
 - a. Determine if surfaces to receive sprayed thermal and acoustical insulation require sealing/priming to insure bonding and/or to prevent discoloration caused by migratory stains.
- B. Evaluation and Assessment:
 - 1. Proceed to installation insulating materials only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Clean substrates to remove substances harmful to insulations or vapor retarders.
 - 2. In areas to receive sprayed thermal and acoustical insulation, provide masking tape, drop cloths, or other satisfactory coverings to prevent overspray from damaging materials and surfaces not to receive spray applied insulation.
 - 3. In areas to receive sprayed thermal and acoustical insulation, prime surfaces if required by the manufacturer's application instructions or determined by examination to require priming.
- B. Demolition/Removal:
 - 1. Remove projections that interfere with placement of the insulation required.
 - a. Remove projections capable of puncturing vapor retarders or of interfering with insulation attachment.



3.03 INSTALLATION

- A. Comply with the insulation manufacturer's written handling and installation instructions applicable to the products and applications indicated in the Contract Documents.
 - 1. For roofing insulation installation, refer to the associated roofing specifications.
 - 2. Submit the insulation manufacturer's written instructions applicable to the products and applications provided.
- B. Envelop the entire area to be insulated by extending the insulation of the thickness indicated in the Contract Documents for the application.
 - 1. Cut and fit solid insulation tightly around obstructions, and fill voids with insulation.
 - 2. Unless multiple layers are shown or required to make up the total thickness required, apply a single layer of insulation to produce the thickness indicated.
 - 3. Determine the minimum thickness of sprayed thermal and acoustical insulation applied in accordance with the requirements of the field test procedure specified in ASTM E 605.
- C. Install insulation that is undamaged, dry, and unsoiled, and that has not been left exposed to ice and snow.
- D. Installing General Building Insulation:
 - 1. Using the method indicated and complying with manufacturer's written instructions, furnish and install general building insulation to or into the substrates that provide support for the insulation to produce a permanent installation.
 - a. If no specific method is indicated, bond the mineral-fiber blanket units to the substrate with adhesive, or use mechanical means of anchorage.
 - 2. Seal joints between closed-cell (non-breathing) insulation units as the units are placed by applying an adhesive, mastic, or sealant to the edges of each unit to form a tight seal.
 - a. Fill voids in installed units with adhesive, mastic, or sealant as recommended by the insulation manufacturer.
 - 3. For vapor-retarder-faced units, place the vapor retarder facing toward the conditioned space unless otherwise indicated.
 - a. Do not obstruct ventilation spaces, except for areas where firestopping material is installed.
 - 4. Ensure an airtight installation.
 - a. Seal each area of continuous insulation to the surrounding construction.
 - b. Tape the joints and ruptures in the vapor retarder in a way that insures an airtight seal.



5. Installing Blanket Insulation:

- a. Install mineral-fiber blankets in cavities formed by framing members as follows:
 - 1) Provide blanket widths and lengths that fill the cavities formed by the framing members.
 - a) If more than one length is required to fill a cavity, provide lengths that will produce a snug fit at the ends of adjoining blankets.
 - 2) Produce a friction fit between the edges of insulation blankets and the adjoining framing members.
 - 3) Wherever cavity heights in metal-framed walls exceed 96 inches, mechanically support unfaced blankets, and support faced blankets by taping stapling flanges to the flanges of the metal framing studs.

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6. Installing Expanding Foam Insulation:

- a. Do not apply expanding foam insulation until the installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
- b. Install expanding spray-applied foam insulation in accordance with the manufacturer's printed instructions to assure that cavity walls are completely filled where indicated in the Contract Drawings.

7. Installing Loose-Fill Insulation:

- a. Do not apply loose cellulosic insulation until the installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
- b. Install self-supported, spray-applied, loose cellulosic insulation where indicated in the Contract Drawings in accordance with the manufacturer's printed instructions to assure that cavity walls are completely filled.
- c. As the cellulosic insulation is installed, use methods recommended by the insulation manufacturer to fill the cavity flush with the edges of the studs.

8. Installing Sprayed Thermal and Acoustical Insulation:

- a. Spray-apply the acoustical and thermal insulation onto the substrate surface where indicated in the Contract Drawings in accordance with the manufacturer's printed instructions to assure that the surfaces are covered to at least the required minimum thickness.
- b. Keep overspray to a minimum.
- c. Remove and properly dispose of overspray.
- d. Cure sprayed acoustical and thermal insulation using continuous natural or mechanical ventilation.

9. Installing Rigid Thermal Insulation:



- a. Install rigid thermal insulation where indicated in the Contract Drawings in accordance with the manufacturer's printed instructions.
 - b. Install rigid thermal insulation boards vertically, with the long joints butted tightly together, and secure it to the substrates using mechanical fasteners such as nails or staples or adhesive as recommended by the rigid thermal insulation manufacturer, and spaced as recommended by the manufacturer.
 - 1) Ensure that the mechanical fasteners are driven to the depth recommended by the rigid thermal insulation manufacturer, but do not overdrive the fasteners.
 - c. Using a utility knife and straight edge, trim the rigid thermal insulation board to conform to irregular wall angles, projections, or wall surfaces less than board width or height.
- E. Installing Safing Insulation:
1. Install safing insulation so it fills the gap between the top of the partition and the horizontal material above, unless shown otherwise on the Contract Drawings.
 2. Complete the safing assembly by applying sealant as indicated in Section II, Requirements for Fire Protection, in GA-600.

3.04 CLEANING

- A. Waste Management:
1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.C.11, 1.05.B.2, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System





SECTION 07275

FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for a fluid applied, vapor permeable air barrier membrane system located in the non-accessible portion of the wall, and including methods for bridging and sealing air leakage pathways in roof and foundation junctions, window and door openings, control and expansion joints, masonry ties, piping and other penetrations through the wall assembly.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 01732 - Cutting and Patching.
 - 5. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CMU: Concrete masonry unit.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. M.D.: Machine direction.
 - 4. MSDS: Material safety data sheets.
 - 5. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.



2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM C 920 – Standard Specifications for Elastomeric Joint Sealants.
 - b. ASTM C 1193 – Standard Guide for Use of Joint Sealants.
 - c. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - d. ASTM D 570 – Standard Test Method for Water Absorption of Plastics.
 - e. ASTM D 1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
 - f. ASTM D 1876 – Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
 - g. ASTM D 1938 – Standard Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by Single-Tear Method.
 - h. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - i. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.
 - j. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - k. ASTM E 96/E 96M – Standard Test Methods for Water Vapor Transmission of Materials.
 - l. ASTM E 154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 - m. ASTM E 162 – Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
 - n. ASTM E 1186 – Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
 - o. ASTM E 2178 - Standard Test Method for Air Permeance of Building Materials.
 - p. ASTM E 2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. Institute for Sustainability Infrastructure (ISI):



- a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of the fluid-applied membrane air barrier with the installation of the roofing membrane and base flashing to ensure continuity of the air barrier with the roofing membrane.
- B. Pre-Installation Meetings:
 - 1. Prior to the commencement of field operations, schedule and conduct a pre-installation conference in accordance with the requirements specified in Section 01316, Project Meetings, to establish the procedures for maintaining optimum working conditions, and to coordinate the Work of this Section with related and adjacent work.
 - 2. Attendees must include the Contractor, the installer of the fluid-applied membrane air barrier, the Program/Project Manager, and the fluid-applied membrane air barrier system manufacturer's field representative.
 - 3. The agenda for the pre-installation conference must include, but in not limited to, the following:
 - a. Review of fluid-applied membrane air barrier submittals.
 - b. Review of surface preparation requirements, discussion of the minimum curing period, and installation procedures.
 - c. Review of special details and flashings.
 - d. The sequence of construction, the responsibilities of the attendees, and the schedule for subsequent operations.
 - e. Review of mock-up requirements.
 - f. Review of inspection, testing, protection, and repair procedures.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Membrane air barrier.
 - 2) Liquid membrane.
 - 3) Wall primer.
 - 4) Flexible membrane wall flashing.
 - 5) Joint reinforcing strip.
 - 6) Transition membrane.
 - 7) Substrate patching membrane.
 - 8) Sprayed polyurethane foam sealant.
 - 9) Joint sealant.



- b. Shop Drawings:
 - 1) Fluid-applied membrane air barrier system.
 - c. Samples:
 - 1) Fluid applied membrane.
 - 2) Transition membrane.
 - 3) Through wall flashing.
 - d. Certificates:
 - 1) Fluid-Applied Membrane Air Barrier Certificate-of-Compliance.
 - e. Qualification Statements:
 - 1) Fluid-applied membrane air barrier manufacturer's qualifications.
 - 2) Fluid-applied membrane air barrier applicator's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Tested physical and performance properties of air barrier.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's published instructions for evaluating, preparing, and treating substrates.
 - 2) Fluid-applied membrane air barrier manufacturer's published installation instructions.
 - c. Source Quality Control Submittals:
 - 1) Certified product test report showing compliance of the proposed air barriers with the requirements for air permeance.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.
 - b. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coating within the buildings weather barrier.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Fluid-Applied Membrane Air Barrier Material Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Testing and Inspection Agency Qualifications:



- a. To perform testing and inspections, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 1. Fluid-Applied Membrane Air Barrier Manufacturer's Qualifications:
 - a. Acquire fluid-applied membrane air barrier systems that have been manufactured and marketed by a firm having a minimum of 20 years experience in the production and sales of waterproofing and air barriers.
 - b. Submit the fluid-applied membrane air barrier manufacturer's qualifications evidencing the ability of the proposed manufacturer to meet the requirements specified, and including a list of projects of similar design and complexity to the Work required by this Contract that the proposed manufacturer has completed within the past 5 years, to the Program/Project Manager for approval.
 2. Fluid-Applied Membrane Air Barrier Applicator's Qualifications:
 - a. Engage a firm experienced in applying air barrier materials similar in material, design, and extent to those specified for this Contract; and whose work has resulted in applications exhibiting a record of successful in-service performance.
 - b. Submit the fluid-applied membrane air barrier applicator's qualifications to the Program/Project Manager for approval.
- C. Certifications:
 1. Fluid-Applied Membrane Air Barrier Certificate-of-Compliance:
 - a. Submit a Certificate-of-Compliance for the fluid-applied membrane air barriers, signed by the product manufacturer, and certifying the air barrier and accessory materials to be provided under this Contract are compatible with the materials that will connect to or that will come into contact with the air barrier to the Program/Project Manager for approval.
- D. Site Samples:
 1. Submit representative Samples of the following materials to the Program/Project Manager for approval:
 - a. Fluid applied membrane.
 - b. Transition membrane.
 - c. Through wall flashing.
- E. Mock-Ups:
 1. After the Samples have been approved but prior to beginning to install the fluid-applied membrane air barrier systems, construct exterior wall assembly mockups in accordance with the requirements specified in



Section 01454, Mock-Up Requirements, and that incorporate the air barrier work relative to backup wall construction, external cladding, window, door frame and sill, insulation, and flashing to demonstrate the surface preparation, the crack and joint treatment, and the sealing of gaps, terminations, and penetrations of the air barrier membrane.

- a. Build the mockups in the locations and of the size indicated on the Contract Drawings; or, if not indicated, as directed by Program/Project Manager.
 - b. Build mockups that include the components required by the system, and that match the systems' components and use the installation methods to be used to install the production Work, to construct the mock-ups.
 - c. Coordinate construction of the mockup so the Testing and Inspection Agency can inspect the air barrier installation before the external insulation and cladding is installed.
2. If the Program/Project Manager determines that the mockups do not comply with the specified requirements, reconstruct the mockups including the air barrier until the mockups are approved by the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Sequence deliveries of fluid-applied membrane air barrier system materials to the Site to avoid delays, but to minimize onsite storage.
2. Deliver fluid-applied membrane air barrier system materials to the Site in their manufacturer's original labeled packaging.
3. Remove damaged fluid-applied membrane air barrier system material from the Site, and dispose of it in accordance with the applicable regulations.

B. Storage and Handling Requirements:

1. Store and handle the fluid-applied membrane air barrier system materials in strict compliance with their manufacturer's instructions, recommendations, and material safety data sheets (MSDS).
2. Protect the fluid-applied membrane air barrier system materials from damage from sunlight, weather, excessive temperatures, and construction operations.
 - a. Do not double-stack pallets of fluid applied membrane components on the Site.
 - b. Provide cover on the top and all sides of the fluid-applied membrane air barrier system materials, allowing for adequate ventilation.
 - c. Protect fluid-applied membrane components from freezing and extreme heat.

C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Apply the fluid-applied air barrier within the range of ambient and substrate temperatures recommended by the fluid-applied membrane air barrier manufacturer.
2. Apply joint sealants that form part of the air barrier assembly within joint sealant manufacturer's recommended application temperature ranges.
 - a. If the sealant cannot be applied within these temperature ranges, consult the joint sealant manufacturer for their recommendations.
3. Do not apply fluid-applied membrane air barrier to a wet substrate or during snow, rain, fog, or mist.

1.08 WARRANTY

A. Manufacturer Warranty:

1. Fluid-Applied Membrane Air Barrier Material Warranty:
 - a. Warrant the fluid-applied membrane air barrier against defects within the 5-year period after the Date of Substantial Completion:
 - 1) Submit a Fluid-Applied Membrane Air Barrier Material Warranty on the fluid-applied membrane air barrier manufacturer's standard form in which the fluid-applied membrane air barrier manufacturer agrees, without monetary limitation, to replace fluid-applied membrane air barrier that when installed and used in strict conformance with the manufacturer's published instructions fails within the specified warranty period, to the Program/Project Manager for approval.
 - 2) Failures include, but are not limited to, the following:
 - a) Failure within the specified warranty period to maintain an air permeance rating not exceeding 0.004 cubic feet per minute per square foot (0.02L/s/m²) when tested in accordance with the method specified in ASTM E 2178.
 - b) Failure within the specified warranty period to maintain a vapor permeance rating greater than 10 perms when tested in accordance with Method B specified in ASTM E 96/E 96M.

PART 2 PRODUCTS

2.01 FLUID-APPLIED MEMBRANE AIR BARRIER SYSTEMS

A. Manufacturers:

1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain the primary fluid-applied membrane air barrier material and through wall flashing from a single source from a single manufacturer.
 - a) If vapor permeable and a vapor impermeable air barrier is required for the Work this Contract, obtain the vapor permeable and vapor impermeable air barrier and through wall flashing from a single source from a single manufacturer.
- B. Sustainability Requirements:
 1. Low Emitting Materials – Paints and Coatings
 - a. Provide fluid applied air barrier with a VOC content of 50g/L or less.
 2. Low Emitting Materials – Adhesives and Sealants
 - a. Provide Architectural Non-Porous Sealant Primers with not more than 250 grams per Liter less water.
 - b. Provide Architectural Porous Sealant Primers with not more than 775 grams per Liter less water.
- C. Description:
 1. The fluid-applied membrane air barrier system is a continuous air barrier to control air leakage into, or out of the conditioned space at building envelopes designed and constructed to control air infiltration and exfiltration.
 2. The fluid-applied membrane air barrier can also be applied to interior partitions between conditioned spaces and spaces designed to maintain temperature or humidity levels which differ from those in the conditioned spaces by more than 50 percent of the difference between the conditioned spaces and design ambient conditions.
 3. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 2) Provide liquid-type materials complying with the VOC limits of the Authorities Having Jurisdiction.
- D. Performance:
 1. Provide fluid-applied, vapor permeable membrane air barrier having the following minimum physical properties and performance:



- a. Membrane Air Permeance:
 - 1) Provide fluid-applied membrane air barrier having a membrane air permeance not exceeding 0.0004 cubic feet per minute per square foot of surface area at a pressure difference of 1.57 pounds-force per square foot (0.002L/s/m² of surface area at 75Pa) when the specified thickness is tested in accordance with the requirements specified in ASTM E 2178.
 - b. Membrane Vapor Permeance:
 - 1) Provide fluid-applied membrane air barrier having a membrane vapor permeance not less than 11.2 perms (649.6ng/Pa/s/m²) when tested in accordance with the methods specified in ASTM E 96/E 96M.
 - c. Assembly Air Leakage:
 - 1) Provide a continuous air barrier assembly that has air leakage less than 0.0008 cubic feet per minute per square foot of surface area when under a pressure differential of 0.3 inch water gage (1.57 pounds per square foot, or 0.004L/s/m² of surface area at 75Pa) when tested in accordance with the method specified in ASTM E 2357.
 - d. Ultraviolet (UV) Radiation Exposure Limit:
 - 1) Provide fluid-applied membrane air barrier having an ultraviolet (UV) radiation exposure limit of not more than 180 calendar days when tested in accordance with the methods specified in ASTM D 412 and with Method B specified in ASTM E 96/E 96M.
 - e. Structural Loading:
 - 1) Provide fluid-applied membrane air barrier that is capable of withstanding positive and negative combined design wind, fan, and stack pressures on the envelope without damage or displacement, and capable of transferring the load to the structure.
 - 2) Provide fluid-applied membrane air barrier that will not displace adjacent materials under full load.
- E. Design Criteria:
- 1. Provide a durable or maintainable fluid-applied membrane air barrier capable of performing as a continuous vapor-permeable air barrier with all joints made airtight and as a liquid-water drainage plane flashed to discharge incidental condensation or water penetration to the exterior.
 - 2. Provide fluid-applied membrane air barrier assemblies capable of accommodating substrate movement, construction material changes, and transitions at perimeter conditions; and of sealing substrate expansion and control joints, without deterioration and air leakage exceeding the specified limits.
 - 3. Provide auxiliary materials recommended by the air barrier manufacturer for their intended use, and that are compatible with the air barrier membrane.



4. Product Data:
 - a. Obtain the fluid-applied membrane air barrier manufacturer's Product Data for the fluid-applied membrane air barrier system, including auxiliary materials and the manufacturer's published instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.
 - b. Submit the Product Data to the Program/Project Manager for approval.
5. Shop Drawings:
 - a. Prepare Shop Drawings that show the locations and extent of the fluid-applied membrane air barrier system.
 - 1) Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 2) Include details of interfaces with other materials that form part of air barrier.
 - 3) Include details of mockups.
 - b. Submit the fluid-applied membrane air barrier system Shop Drawings to the Program/Project Manager for approval.

F. Materials:

1. Membrane Air Barrier:
 - a. Provide a fluid-applied, fully-adhered, vapor-permeable single component acrylic membrane air barrier that cures to form a resilient, monolithic, fully bonded elastomeric sheet when applied to construction surfaces.
 - b. Manufacturers:
 - 1) Grace Construction Products, Perm-A-Barrier VP, <http://www.na.graceconstruction.com>.
 - 2) Approved equal.
2. Liquid Membrane:
 - a. Provide rubberized, asphalt-based liquid membrane designed to seal terminations, edges of patches, and overlaps in detail areas.
 - b. Manufacturers:
 - 1) Grace Construction Products, Bituthene Liquid Membrane, <http://www.na.graceconstruction.com>.
 - 2) Approved equal.
3. Flexible Membrane Wall Flashing:
 - a. Provide flexible membrane wall flashing consisting of 0.97mm (36-mil) thick self-adhesive rubberized asphalt integrally bonded to 0.1mm (4-mil) thick cross-laminated, high-density polyethylene film to produce at least a 1.0mm (40-mil) thick membrane, and interleaved with disposable silicone-coated release paper to be removed when the flashing is installed.
 - b. Provide flexible membrane wall flashing having the properties specified in Table 07275-2.



Table 07275-2 Flexible Membrane Wall Flashing Properties		
Property	Test Method	Requirement
Water Vapor Transmission	ASTM E 96/E 96M Method B	2.9 ng/m ² /s/Pa (0.05 perms)
Water Absorption	ASTM D 570	0.1 percent by weight maximum
Puncture Resistance	ASTM E 154	356N (80 pounds) minimum
Tear Resistance		
Initiation	ASTM D 1004	58N (13.0 pounds) M.D. minimum
Propagation	ASTM D 1938	40N (9.0 pounds) M.D. minimum
Lap Adhesion at minus 4 degrees Celsius (25 °F)	ASTM D 1876	880N/m (5.0 pounds/inch) of width
Low Temperature Flexibility	ASTM D 1970	Unaffected to minus 43 degrees Celsius (-45 °F)
Tensile Strength	ASTM D 412 Die C Modified	5.5MPa (800 psi) minimum
Elongation, Ultimate Failure of Rubberized Asphalt	ASTM D 412 Die C	200 percent minimum

- c. Manufacturers:
 - 1) Grace Construction Products, Perm-A-Barrier Detail Membrane, <http://www.na.graceconstruction.com>.
 - 2) Approved equal.
- 4. Joint Reinforcing Strips:
 - a. Provide the air barrier manufacturer's approved joint reinforcing tape.
- 5. Transition Membrane:
 - a. Provide transition membrane consisting of 0.97mm (36-mil) thick self-adhesive rubberized asphalt integrally bonded to 0.1mm (4-mil) thick cross-laminated, high-density polyethylene film to produce at least a 1.0mm (40-mil) thick membrane, and interleaved with disposable silicone-coated release paper to be removed when the flashing is installed.
 - b. Provide transition membrane having the properties specified in Table 07275-3.



Table 07275-3 Transition Membrane Properties		
Property	Test Method	Requirement
Water Vapor Transmission	ASTM E 96/E 96M Method B	2.9 ng/m ² /s/Pa (0.05 perms)
Water Absorption	ASTM D 570	0.1 percent by weight maximum
Puncture Resistance	ASTM E 154	356N (80 pounds) minimum
Tear Resistance		
Initiation	ASTM D 1004	58N (13.0 pounds) M.D. minimum
Propagation	ASTM D 1938	40N (9.0 pounds) M.D. minimum
Lap Adhesion at minus 4 degrees Celsius (25 °F)	ASTM D 1876	880N/m (5.0 pounds/inch) of width
Low Temperature Flexibility	ASTM D 1970	Unaffected to minus 43 degrees Celsius (-45 °F)
Tensile Strength	ASTM D 412 Die C Modified	5.5MPa (800 psi) minimum
Elongation, Ultimate Failure of Rubberized Asphalt	ASTM D 412 Die C	200 percent minimum

- a. Manufacturers:
 - 1) Grace Construction Products, Perm-A-Barrier Detail Membrane, <http://www.na.graceconstruction.com>.
 - 2) Approved equal.
6. Substrate Patching Membranes:
 - a. Provide the air barrier material manufacturer's standard trowel-grade substrate filler.
 - b. Manufacturers:
 - 1) Grace Construction Products, Bituthene Liquid Membrane, <http://www.na.graceconstruction.com>.
 - 2) Approved equal.
7. Sprayed Polyurethane Foam Sealant:
 - a. Provide one-component or two-component, foamed-in-place, polyurethane foam sealant having the following properties:
 - 1) Density: 1.5 pounds per cubic foot to 2.0 pounds per cubic foot (24kg/m³ to 32kg/m³).



- 2) Flame Spread Index: 25 or less when tested in accordance with the method specified in ASTM E 162.
 - b. Provide the primer and noncorrosive substrate cleaner recommended by the foam sealant manufacturer.
8. Joint Sealant:
 - a. Provide joint sealant complying with the requirements for single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure specified in ASTM C 920, except provide Use O joint sealant where applicable for the joint substrates.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Air Permeance Test:
 - a. Test Procedure:
 - 1) Based on evaluation of comprehensive tests performed on the proposed air barriers by a qualified testing agency, submit a certified product test report showing compliance of the proposed air barriers with the requirements for air permeance specified in ASTM E 2178.
 - b. Acceptance Criteria:
 - 1) A certified product test report showing the proposed air barriers comply with the requirements for air permeance specified in ASTM E 2178 allow those products to pass the Air Permeance Test.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the fluid-applied membrane air barrier system installer present, examine the substrates, areas, and conditions where this air barrier system will be installed for compliance with the installation requirements and other conditions affecting the performance of the architectural metal.
 - a. Verify that the substrates are sound, and free of oil, grease, dirt, excess mortar, or other contaminants.
 - b. Verify that concrete has cured and aged for the minimum time period recommended by the fluid-applied membrane air barrier manufacturer.
 - c. Verify that masonry joints are struck flush, and completely filled with mortar.
 - d. Verify that surfaces are sound and free of voids, spalled areas, loose aggregate, and sharp protrusions.
- B. Pre-Installation Testing:



1. Capillary Moisture Test:
 - a. Test Procedure:
 - 1) Test the concrete substrates for capillary moisture in accordance with the plastic sheet method specified in ASTM D 4263.
 - b. Acceptance Criteria:
 - 1) Verify that concrete is visibly dry and free of moisture.

C. Evaluation and Assessment:

1. Proceed to install the fluid-applied membrane air barrier system only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. To prevent spillage and overspray affecting other construction, mask off adjoining surfaces not to be covered by fluid-applied membrane air barrier.

B. Surface Preparation:

1. Comply with the requirements for substrate preparation specified in the fluid-applied membrane air barrier manufacturer's Product Data.
 - a. Protect substrates from environmental conditions that will affect the performance of the fluid-applied membrane air barrier.
2. Clean, prepare, treat, and seal the substrates in accordance with the fluid-applied membrane air barrier manufacturer's written instructions.
 - a. Furnish clean, dust-free, and dry substrates for fluid-applied membrane air barrier application.
 - 1) Remove dust, dirt, loose stone, and debris.
 - b. Remove contaminants such as grease, oil, and wax from exposed surfaces.
 - 1) Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
3. Substrate Repair, Remediation, and Other Preparation:
 - a. Use repair materials and methods that are acceptable to the manufacturer of the fluid-applied air barrier system.
 - b. Install flashing and treat construction joints as recommended by the fluid-applied membrane air barrier manufacturer.
 - c. Provide continuous support for the air barrier by covering gaps in the substrate plane using stainless-steel sheet mechanically fastened to the structural framing to form a smooth transition from one substrate plane to another.
 - d. At changes in the plane of the substrate, such as at sharp corners and edges, apply a sealant or substrate patching membrane to form a smooth transition from one plane to the other.
 - e. Exterior Sheathing Panel Substrates:



- 1) Ensure that the boards are sufficiently stabilized, and that the corners and edges have been fastened with appropriate screws.
 - 2) Pre-treat all board joints with 50mm (2inch) to 75mm (3 inch) wide self-adhesive tape of a type recommended by the manufacturer.
 - a) Fill gaps greater than 6mm (1/4 inch) with mastic or caulk, and allow sufficient time for the mastic or caulk to fully cure before applying the tape and fluid applied air barrier system.
 - f. Gypsum Sheathing:
 - 1) Fill gypsum sheathing joints wider than 1/4 inch (6mm) with sealant in accordance with the requirements specified in ASTM C 1193 and with the fluid-applied membrane air barrier manufacturer's published instructions.
 - 2) Prior to applying fluid air barrier membrane, apply tape to the gypsum sheathing joints.
 - g. Concrete and Masonry Substrates:
 - 1) Prepare, treat, rout, and fill joints and cracks in concrete and masonry substrate in accordance with the requirements specified in ASTM C 1193 and the fluid-applied membrane air barrier manufacturer's written instructions.
 - a) Before coating the concrete and masonry surfaces with fluid-applied membrane air barrier, remove dust and dirt from the joints and cracks in accordance with the requirements specified in ASTM D 4258.
 - 2) Remove fins, ridges, mortar, and other projections; and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.
 - 3) Ensure that the concrete block and brick substrates have smooth trowel-cut mortar joints, struck full and flush.
 - 4) Fill all voids and holes in masonry, particularly in the mortar joints, with a lean mortar mix, non-shrinking grout, or parge coat.
 - 5) Remove excess mortar from masonry ties, shelf angles, and other obstructions.
 - 6) Prime concrete and masonry substrate as required.
- C. Demolition/Removal:
1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 APPLICATION

- A. Ensure that all penetrations of the air barrier and paths of air infiltration/exfiltration are made airtight.
1. Join the air barrier to the air barrier material of adjacent systems in an airtight and flexible manner, allowing for the relative movement of systems due to thermal and moisture variations and creep.



B. Air Barrier Membrane:

1. Apply the fluid-applied air barrier membrane in accordance with the air barrier manufacturer's instructions so a continuous air barrier is achieved.
 - a. Submit the fluid-applied membrane air barrier manufacturer's published installation instructions to the Program/Project Manager for information.
2. Apply a continuous unbroken vapor-permeable membrane air barrier onto the substrates to the following minimum thicknesses:
 - a. Wet Film Thickness: 90 mils (2.4mm).
 - b. Dry Film Thickness: 45 mils (1.2mm).
3. Apply the fluid-applied air barrier membrane so it has full contact around protrusions, such as masonry ties.

C. Transition Membrane:

1. Apply primer to substrates that will receive transition membrane at the required rate and allow it to dry.
 - a. Limit priming to areas that will be covered by transition tape in the same day.
 - b. Re-prime areas exposed for more than 24 hours.
 - c. Prime glass-fiber-surfaced gypsum sheathing not to be covered with air membrane material with the number of prime coats needed to achieve the required bond, and allow adequate drying time between coats.
2. Install strips, transition membrane, and other auxiliary materials in accordance with the fluid-applied air barrier manufacturer's published instructions so it forms a seal with the adjacent construction and maintains a continuous air barrier.
 - a. Install flashings only after the air barrier has been applied.
 - b. Install strip transition membrane on the roofing membrane and the base flashing so both substrates are covered by a minimum of 3 inches (75mm) of transition membrane.
3. At end of each working day, seal the top edge of strips and transition membrane strips to the substrate using termination mastic.
4. Apply joint sealants that form part of the air barrier assembly.
5. Wall Openings:
 - a. Prime the concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors.
 - b. Apply transition strips so a minimum coverage of 3 inches (75mm) of is achieved over both substrates.
 - 1) Maintain 3 inches (75mm) of full contact with perimeter frames over firm bearing so not less than 1 inch (25mm) of full contact is achieved.
 - 2) Firmly roll the transition membrane to enhance adhesion.
6. Fill gaps in the perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.



7. Repair punctures, voids, and deficient lapped seams in strips and transition strips.
 - a. Slit and flatten fishmouths and blisters.
 - b. Patch these defects using transition strips that extend 6 inches (150mm) beyond the repaired areas in the strip direction.
- D. Special Techniques:
 1. Liquid Membrane:
 - a. To seal terminations, edges of patches, and overlaps in detail areas provide liquid membrane.
 2. Wall Primer:
 - a. For throughwall flashing and tapes applied to the substrate, provide wall primer.
- E. Interface with Other Work:
 1. Using auxiliary materials, connect and seal the exterior wall air barrier membrane continuously to the roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings.
 2. Provide connection between the following systems:
 - a. Foundations and walls.
 - b. Walls and windows or doors.
 - c. Different wall systems.
 - d. Walls and roofs.
 - e. Walls and roofs over unconditioned space.
 - f. Walls, floors, and roofs across construction, control, and expansion joints.
 - g. Walls, floors and roofs to utility, pipe and duct penetrations.

3.04 REPAIR/RESTORATION

- A. Correct deficiencies in, or remove, air barrier that does not comply with the specified requirements.
 1. Repair the substrates, and reapply the air barrier components.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when fluid-applied air barrier is being applied, the Testing and Inspection Agency must perform routine and other inspections and testing of materials and prepare test reports.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow inspection and testing personnel to be assigned,



- and to provide sufficient time for quality tests to be performed and completed.
- b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Do not cover air barrier until it has been tested and inspected by the Testing and Inspection Agency.
 3. Air Leakage Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will test air barrier assemblies for evidence of air leakage in accordance with the method specified in ASTM E 1186 using a smoke pencil with pressurization or depressurization.
 - b. Acceptance Criteria:
 - 1) Air barrier assemblies showing no evidence of air leakage pass the Air Leakage Test.
 4. Inspections:
 - a. Air barrier materials and installation are subject to inspections to verify the following compliance with the specified requirements:
 - 1) Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2) Continuous structural support of air barrier system has been provided.
 - 3) Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings.
 - 4) Site conditions for the application temperature and dryness of substrates have been maintained.
 - 5) Maximum exposure time of materials to ultraviolet (UV) deterioration has not been exceeded.
 - 6) Surfaces have been primed where applicable.
 - 7) Laps in strips and transition strips have complied with at least the minimum requirements, and have been shingled in the correct direction or mastic has been applied on exposed edges, with no fishmouths.
 - 8) Termination mastic has been applied on cut edges.
 - 9) Strips and transition strips have been firmly adhered to the substrate.
 - 10) Compatible materials have been used.
 - 11) Transitions at changes in direction and structural support at gaps have been provided.



- 12) Connections between assemblies, both membrane and sealants, have complied with the requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
- 13) All penetrations have been sealed.

B. Non-Conforming Work

1. Remove deficient air barrier components, replace the deficient components with acceptable components, and retest the replacement components as specified herein.

3.06 CLEANING

- A. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by the manufacturer of the affected construction.
- B. Remove masking materials after installation.
- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect the air barrier system from damage during its application and the remainder of the construction period in accordance with the manufacturer's published instructions.
- B. Protect air barrier from exposure to ultraviolet (UV) light and harmful weather exposure as required by the manufacturer.
 1. Remove air barrier exposed for more than 150 days, and replace the removed air barrier with new material.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 07412

METAL WALL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for concealed-fastener, lap-seam metal wall panels.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene propylene diene terpolymer M-class rubber.
 - 2. PVC: Polyvinyl-chloride.
 - 3. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 4. NRC: Noise reduction coefficient.
 - 5. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties.
 - 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Volatile Organic Compounds (VOC): Generally meant to refer to organic chemical compounds having high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- C. Reference Standards:
 - 1. American Architectural Manufacturers Association (AAMA):



- a. AAMA 621 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
2. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM A 755/A 755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - c. ASTM A 792/A 792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - d. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members.
 - e. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - f. ASTM C 920 - Standard Specification for Elastomeric Joint Sealers.
 - g. ASTM C 1311 - Standard Specification for Solvent Release Sealants.
 - h. ASTM E 1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. SMACNA Architectural Sheet Metal Manual.
6. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
7. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
8. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved



Agency, and the City, prior to incorporating items requiring testing by them into the Work.

2. Coordinate the panel attachment locations with other trades.
 - a. Support fasteners must not obstruct the girt line.
3. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) Exterior elevations drawn to scale.
 - b) Penetrations.
 - c) Wall-mounted items.

B. Pre-Installation Meetings:

1. Attend a pre-installation meeting at the Site held in compliance with the requirements of Section 01316, Project Meetings, to discuss the requirements for constructing the metal wall panels to be provided under this Contract.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Zinc-coated (galvanized) steel sheet.
 - 2) Aluminum-zinc alloy-coated steel sheet.
 - 3) Sealant tape.
 - 4) Joint sealant.
 - 5) Solvent-release sealant.
 - 6) Metal framing.
 - 7) Panel fasteners.
 - 8) Concealed-fastener, lap-seam metal wall panels.
 - 9) Exposed coil-coated finishes.
 - 10) Concealed finishes.
 - 11) Wall panel closures.
 - 12) Wall panel backing plates.
 - 13) Wall panel closure strips.
 - 14) Flashing and trim.
 - b. Shop Drawings:
 - 1) Metal wall panels.
 - c. Samples:
 - 1) Exposed coil-coated finishes.
 - 2) Concealed finishes.
 - d. Qualification Statements:



- 1) Metal wall panel installer's qualifications.
- 2) Professional Engineer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Metal wall panel manufacturer's written panel installation recommendations.
 - 2) Metal wall panel manufacturer's written recommendations for cleaning the panels.
 - b. Source Quality Control Submittals:
 - 1) Structural Performance Test Reports.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealants.
 - d. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coatings within the building's weather barrier.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance instructions for the metal wall panels.
 - b. Warranty Documentation:
 - 1) Metal Wall Panel Warranty.
 - 2) Metal Wall Panel Architectural Finish Warranty.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by a code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - 1) Both continuous and periodic Special Inspections will be performed during the fabrication and erection of structural steel.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Testing and Inspection Agency:
 - a. To perform approval testing and inspections, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Metal Wall Panel Installer's Qualifications:
 - a. Retain an installer that employs workers trained and approved by the metal wall panel manufacturer.
 - b. Submit the metal wall panel installer's qualifications to the Program/Project Manager for approval.
 - 2. Professional Engineer's Qualifications:
 - a. Employ an independent Professional Engineer, registered in the State of Arizona, who is qualified to perform the structural analysis required under this Section.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.
- C. Site Samples:
 - 1. Submit Samples of each type of exposed finish used for the Work of this Section to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Protect metal wall panel materials from the elements and construction activity during transit and at the Site.
- B. Storage and Handling Requirements:
 - 1. Protect the metal finishes by applying the protective coverings recommended by the manufacturer.



2. Store the metal wall panel materials off the ground.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Special Warranties:

1. Warrant the metal wall panel materials and workmanship against failures during the warranty period specified, including but not limited to the following:
 - a. Metal Wall Panel Warranty:
 - 1) Warrant the metal wall panels against defective materials, defective workmanship, defective watertightness, and defective design during the warranty period within 2 years from the Date of Substantial Completion.
 - 2) In the warranty, the manufacturer must agree to repair or replace components of metal wall panels that fail in materials or workmanship within the specified warranty period.
 - b. Metal Wall Panel Architectural Finish Warranty:
 - 1) Warrant the metal wall panel architectural finish against fading, chalking, yellowing, peeling, cracking, pitting, corroding or non-uniformity of color, or gloss deterioration beyond manufacturer's descriptive standards during the warranty period within 20 years from the Date of Substantial Completion.
 - 2) In the warranty, the manufacturer must agree to repair the finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
2. Submit the written Metal Wall Panel Warranty and the Metal Wall Panel Architectural Finish Warranty on the manufacturer's standard form acceptable to the Owner to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 METAL WALL PANEL COMPONENTS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- 3. Product Options:
 - a. Product Data:
 - 1) Obtain Product Data for each type of product proposed for the Work of this Section.
 - 2) Submit the Product Data to the Program/Project Manager for approval.
- B. Description:
 - 1. Provide the components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 2. Regulatory Requirements:
 - a. Phoenix Building Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 3. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Adhesives and Sealants:
 - 1) Provide interior adhesives, sealants, and primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Substrate Specific Applications Metal to Metal: Not more than 30 grams per Liter less water.
 - b) Substrate Specific Applications Plastic Foams: Not more than 50 grams per Liter less water.
 - c) Substrate Specific Applications Porous Material (except wood): Not more than 50 grams per Liter less water.
 - d) Architectural Sealants: Not more than 250 grams per Liter less water.
 - e) Architectural Non-Porous Sealant Primers: Not more than 250 grams per Liter less water.
 - f) Architectural Porous Sealant Primers: Not more than 775 grams per Liter less water.
 - b. Recycled Content
 - 1) Provide Metal Wall Panels whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.



- 2) Provide Metal Framing whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.
 - 3) Provide glass fiber insulation with combined post-consumer recycled content and one-half pre-consumer recycled content that is no less than 25 percent.
 - c. All batt insulation shall be formaldehyde free.
- C. Performance:
 - 1. Structural Performance:
 - a. Provide metal wall panel assemblies capable of withstanding the effects the following loads and stresses within the limits and under the conditions indicated based on testing in accordance with the methods specified in ASTM E 1592:
 - 1) Wind Loads:
 - a) Determine minimum design loads based on a uniform wind pressure of [37.5] pounds•force per square foot. ([1796]Pa) acting inward or outward.
 - 2) Deflection Limits:
 - a) Design metal wall panel assemblies to withstand wind loads with horizontal deflections no greater than 1/180 of the span.
- D. Design Criteria:
 - 1. Delegated Design:
 - a. Design each metal wall panel assembly using the performance requirements and design criteria indicated.
 - 1) Employ a qualified Professional Engineer to furnish a comprehensive engineering analysis.
 - b. Design the metal wall panels so condensation is eliminated on the interior side of the panel, and the joints between panels form weathertight seals.
 - c. Provide panels having the same profile for the full length of the panel, including major ribs and intermediate stiffening ribs.
 - 2. Shop Drawings:
 - a. Prepare Shop Drawings of the metal wall panels that show fabrication and installation layouts; details of edge conditions, joints, panel profiles, corners, anchorages, the attachment system, trim, flashings, closures, accessories, and special details.
 - 1) Distinguish between factory- assembled, shop- assembled, and field-assembled work on the Shop Drawings.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- E. Materials:
 - 1. Panel Materials:
 - a. Metallic-Coated Steel Sheet:



- 1) Provide restricted flatness steel sheet that has been metallic coated using the hot-dip process and pre-painted using the coil-coating process in accordance with the requirements specified in ASTM A 755/A 755M.
 - a) Zinc-Coated (Galvanized) Steel Sheet:
 - (1) Provide structural steel (SS) sheet galvanized in accordance with the requirements for G90 (Z275) Coating Designation specified in ASTM A 653/A 653M.
 - b) Aluminum-Zinc Alloy-Coated Steel Sheet:
 - (1) Provide steel sheet alloy-coated in accordance with the requirements for AZ50 Coating Designation, Grade 50 Class 1 (AZM150 Coating Designation, Grade 340 Class 1) structural steel (SS) specified in ASTM A 792/A 792M.
 - c) Surface:
 - (1) Provide metallic-coated steel sheet having a smooth finish.
 - b. Panel Sealants:
 - 1) Sealant Tape:
 - a) Provide pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape having a release-paper backing
 - b) Provide 1/2-inch (13mm) wide and 1/8-inch (3 mm) thick tape.
 - 2) Joint Sealant:
 - a) Provide elastomeric joint sealant complying with the requirements specified in ASTM C 920, and recommended in writing by the metal wall panel manufacturer.
 - 3) Solvent-Release Sealant:
 - a) Provide butyl-rubber-based, solvent-release sealant complying with the requirements specified in ASTM C 1311.
2. Metal Framing:
 - a. Steel Sheets:
 - 1) Provide cold-formed metallic-coated steel sheet complying with the requirements for nonstructural framing members specified in ASTM C 645; and hot-dip galvanized in accordance with the requirements for Coating Designation G60 (Z180) specified in ASTM A 653/A 653M, or another coating having equivalent corrosion resistance unless otherwise indicated in the Contract Documents.
 - b. Subgirts:
 - 1) Provide subgirts fabricated from the manufacturer's standard C-shaped or Z-shaped sections, and having a nominal thickness of 0.064 inch (1.63mm).
 - c. Zee Clips:
 - 1) Provide zee clips having a nominal thickness of 0.079 inch (2.01mm).



- d. Base and Sill Angles and Channels:
 - 1) Provide base or sill angles or channels having a nominal thickness of 0.079 inch (2.01mm).
3. Panel Fasteners:
 - a. Provide self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand the specified design loads.
 - b. Provide exposed fasteners having heads having plastic caps or a factory-applied coating matching the color of the metal wall panels.
 - c. Provide sealing washers made from ethylene propylene diene terpolymer M-class rubber (EPDM), Polyvinyl-chloride (PVC), or neoprene.

2.02 METAL WALL PANEL ASSEMBLIES

- A. Concealed-Fastener, Lap-Seam Metal Wall Panels:
 1. Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting the side edges of adjacent panels, and mechanically attaching the panels to supports using concealed fasteners and factory-applied sealant in the side laps.
 - a. Provide concealed-fastener, lap-seam metal wall panels having a reveal joint or creased profile.
 - b. Provide panels having coverage of 12 or 16 inches.
 - c. Provide panel heights as indicated on the Contract Drawings.
 2. For zinc-coated (galvanized) steel concealed-fastener, lapped and interconnected seam wall panels, fabricate the panels from sheets having a nominal thickness of 0.028 inch (0.71mm).
 - a. Provide zinc-coated (galvanized) steel concealed-fastener, lap-seam wall panels having a 3-coat fluoropolymer external finish and the color as selected by Program/Project Manager from the manufacturer's full color range.
 3. For aluminum-zinc alloy-coated steel concealed-fastener, lapped and interconnected seam wall panels, fabricate the panels from sheets having a nominal thickness of 0.028 inch (0.71mm).
 - a. Provide aluminum-zinc alloy-coated steel concealed-fastener, lap-seam wall panels having a 3-coat fluoropolymer external finish and the color as selected by Program/Project Manager from the manufacturer's full color range.
 4. Provide the accessories required to create a weathertight installation.
 5. Manufacturers:
 - a. MBCI; Division of NCI Group, Inc., <http://www.mbc.com/>.
 - b. Manufacturer providing an equivalent product approved by the Program/Project Manager.
- B. Shop Fabrication:



1. Using the manufacturer's standard procedures and processes, fabricate and finish the metal wall panels and accessories at the factory to greatest extent possible to produce panels capable of complying with the specified performance requirements.
2. Fabricate metal wall panels complying with profiles and with dimensional and structural requirements indicated in the Contract Documents.
3. If gaskets or sealants are factory installed, fabricate the metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within the panel assembly.
4. Sheet Metal Accessories:
 - a. Fabricate flashing and trim in accordance with the recommendations in the SMACNA Architectural Sheet Metal Manual that apply to the design, dimensions, metal, and other characteristics of the.

C. Finishes:

1. Finish Materials:
 - a. Exposed Coil-Coated Finishes:
 - 1) 3-coat Fluoropolymer Finish:
 - a) Provide a 3-coat fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat complying with the requirements specified in AAMA 621.
 - b. Concealed Finishes:
 - 1) On steel, provide the manufacturer's standard white or light-colored acrylic or polyester backer finish.

2.03 ACCESSORIES

A. Wall Panel Accessories:

1. Unless otherwise indicated, the material and finish of wall panel accessories match the material and finish of metal wall panels.
2. Closures:
 - a. At eaves and rakes, provide closures fabricated of the same metal as the metal wall panels.
3. Backing Plates:
 - a. At panel end splices, provide metal backing plates fabricated from material recommended by the wall panel manufacturer.
4. Closure Strips:
 - a. Provide closure strips fabricated from closed-cell, expanded, cellular, rubber or from crosslinked, polyolefin-foam or closed-cell laminated polyethylene having at least 1-inch (25mm) thick flexible closure strips that have been cut or pre-molded to match the metal wall panel profile.
 - b. Provide closure strips where indicated in the Contract Documents or necessary to ensure weathertight construction.



B. Flashing and Trim:

1. Provide flashing and trim formed from zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet that is at least 0.018-inch (0.46mm) thick and pre-painted with a coil coating.
2. Finish the flashing and trim with same finish system as adjacent metal wall panels.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Structural Performance Test:
 - a. Test Procedure:
 - 1) Have the Testing and Inspection Agency determine the structural performance of the metal wall panel assemblies in accordance with the method specified in ASTM E 1592 under the wind load constraint specified in Subparagraph 2.01C.1.a.1.
 - 2) Have the Testing and Inspection Agency prepare Structural Performance Test Reports documenting the testing results, and submit the reports certified by the Testing and Inspection Agency to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Metal wall panel assemblies testing within the deflection limit specified in Subparagraph 2.01B.1.a.2 pass the Structural Performance Test.

B. Non-Conforming Work

1. Correct deficiencies in metal wall panels that inspections and test reports have indicated are not in compliance with specified requirements.

C. Coordination of Other Tests and Inspections:

1. Notify the code-required Approved Agency responsible for performing special inspections when metal wall panels for this Contract are being fabricated, shipped, and/or tested.
2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify that the building is ready for the installation of the metal wall panels.
 - a. Examine the supporting members to verify the layout and alignment are correct.
 - b. Using laser instruments, field-check the dimensions and the alignment of supports.



- 1) Verify that support members have been installed within 6mm of their theoretical location.
- 2) The offset between any 2 adjacent members may not exceed 3mm.
- c. Verify that structural supports are in place.
 - 1) Before installing the Work of this Section, tighten the diagonal bracing and connections.
- B. Evaluation and Assessment:
 1. Do not proceed installing the metal wall panels until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage that could otherwise result from installation of the metal wall panels.
- B. Surface Preparation:
 1. Install miscellaneous framing, including subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages in accordance with the requirements specified in ASTM C 754.

3.03 ERECTION

- A. Provide metal wall panel metal installed in accordance with the wall panel manufacturer's written installation recommendations.
 1. Submit the metal wall panel manufacturer's written panel installation recommendations to the Program/Project Manager for information.
- B. Metal Wall Panels:
 1. Lap-Seam Metal Wall Panels:
 - a. Fasten metal wall panels to their supports using fasteners at each lapped joint location, and spaced as recommended by the manufacturer.
 - 1) Lap ribbed or fluted sheets one full rib corrugation.
 - a) Apply panels and associated items so a neat and weathertight enclosure is produced.
 - b) Avoid "panel creep" and applications not true to line.
 - 2) Provide metal-backed washers under the heads of exposed fasteners bearing on the weather side of metal wall panels.
 - 3) Locate and space exposed fasteners in a uniform vertical and horizontal alignment.
 - a) Use tools that control the compression uniformly to produce a positive seal without rupturing of washer.



- 4) When installing screw fasteners, adjust the power tool's controlled torque so it compresses the washer tightly without damaging the washer, screw threads, or panels.
 - a) Install screws in predrilled holes.
- 5) Provide sealant tape at the lapped joints of the metal wall panels and between panels and protruding equipment, vents, and accessories.
- 6) Apply a continuous ribbon of sealant tape to the weather-side surface of fastenings on end laps; on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make the panels weathertight.
- 7) At panel splices, nest the panels so the end lap is at least 6 inches (152mm), seal the end laps with butyl-rubber sealant, and fasten the end laps together using interlocking clamping plates.

C. Flashing and Trim:

1. Provide flashing and trim as required to seal against weather and to provide a finished appearance.
 - a. Install flashing and trim so laps, joints, and seams will be permanently watertight and weather resistant.
2. Install flashing and trim in accordance with the manufacturer's written installation instructions and the SMACNA Architectural Sheet Metal Manual so the performance requirements specified are complied with.
 - a. Locations requiring flashing and trim include, but are not limited to, bases, drips, sills, jambs, corners, end walls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers.
 - b. Provide concealed fasteners where possible, and set metal wall panels true to line and level as indicated in the Contract Documents.

D. Accessories:

1. Install accessories so positive anchorage to building and weathertight mounting is assured.
2. Coordinate the installation of accessories with flashings and other components.

E. Special Techniques:

1. Install the metal wall panels to allow for thermal expansion.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when metal wall panels are being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials and installation.



- a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow personnel to be assigned and to provide sufficient time for quality tests and inspections to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Inspections:
 - a. Periodic Special Inspections will be performed during the erection of metal wall panels.
- B. Non-Conforming Work
 1. Correct deficiencies in metal wall panels that inspections and test reports have indicated are not in compliance with specified requirements.
 - a. Promptly remove and replace Work that does not comply with specified requirements.

3.05 CLEANING

- A. Remove the temporary protective coverings and strippable protective film from the exterior panel skins immediately after installation of each panel.
- B. Clean the exposed surfaces of the Work promptly after installation is completed in accordance with the metal wall panel manufacturer's recommendations.
 1. Submit the metal wall panel manufacturer's written recommendations for cleaning the metal wall panels to the Program/Project Manager for information.
- C. After metal wall panels have been installed, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- D. During construction, keep the metal wall panels clean.
- E. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.06 PROTECTION

- A. Protect the Work as required to ensure the metal wall panels will be without damage at the time of Final Acceptance.

3.07 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit maintenance instructions for the metal wall panels to the Program/Project Manager for inclusion in Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition



SECTION 07430

COMPOSITE PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for a watertight rout and return, dry composite panel system as detailed on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 01454 - Mock-Up Requirements.
 - 5. Section 01732 - Cutting and Patching.
 - 6. Section 01780 - Closeout Submittals.
 - 7. Section 05120 - Structural Steel.
 - 8. Section 05400 - Cold-Formed Metal Framing.
 - 9. Section 07275 - Fluid-Applied Membrane Air Barriers.
 - 10. Section 07920 - Joint Sealants.
 - 11. Section 09253 - Gypsum Sheathing.
 - 12. Section 09961 – Fluoropolymer Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CEG: Continuous edge grip.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. EPDM: Ethylene propylene diene terpolymer M-class rubber.
 - 4. PVDF: Polyvinylidene fluoride, a highly non-reactive and pure thermoplastic fluoropolymer.
 - 5. SBS: Styrene-butadiene-styrene.
 - 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.



B. Reference Standards:

1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 501.2 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
3. ASTM International (ASTM):
 - a. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - b. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
 - c. ASTM C 864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
 - d. ASTM C 1115 - Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
 - e. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
 - f. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - g. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - h. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - i. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. International Organization for Standardization (ISO):
 - a. ISO 9001 – Quality Management System – Requirements.
7. National Fire Protection Association (NFPA):
 - a. NFPA 285 – Fire Test Method for Evaluation Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.
8. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the panel attachment locations with other trades.
 - a. Support fasteners must not obstruct the girt line.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Composite panels.
 - 2) Underlayment.
 - 3) Fasteners.
 - 4) Gaskets.
 - 5) Sealants.
 - 6) Wall panel support system.
 - 7) Organic coating.
 - b. Shop Drawings:
 - 1) Composite panels.
 - 2) Layout of all composite panel Work.
 - c. Samples:
 - 1) Flat panel Samples of the composite panel materials.
 - d. Certificates:
 - 1) Composite panel system manufacturer's Certificates of Compliance.
 - e. Qualification Statements:
 - 1) Composite panel installer's qualifications.
 - 2) Composite panel manufacturer's acceptance of the composite panel installer.
 - 3) Composite panel manufacturer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Composite panel manufacturer's written installation instructions.



- 2) Panel manufacturer's written recommendations for cleaning the composite panels.
 - 3) Sealant manufacturer's written installation instructions
 - b. Manufacturer's Reports:
 - 1) Factory-authorized service representative report of the results of his or her inspection.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance instructions for the composite panel finishes.
 - b. Warranty Documentation:
 - 1) Composite Panel Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Testing and Inspection Agency:
 - a. To perform testing and inspections, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Composite Panel Installer's Qualifications:
 - a. Unless otherwise accepted by the Program/Project Manager, employ an installer that employs a quality management system complying with the program requirements specified in ISO 9001, or with the program requirements specified for a similar quality management system.
 - 1) Employ a firm having a minimum of 10 years' experience installing composite panel systems similar to those required as the Work to be performed under this Section, and that have a record of successful in-service performance.
 - b. Submit the composite panel installer's qualifications to the Program/Project Manager for approval.
 - c. Submit the composite panel manufacturer's acceptance of the composite panel installer to the Program/Project Manager for information.
 - 2. Composite Panel Manufacturer's Qualifications:
 - a. Unless otherwise accepted by the Program/Project Manager, employ a manufacturer that employs a quality management system complying with the program requirements specified in ISO 9001, or with the program requirements specified for a similar quality management system.



- b. Submit the composite panel manufacturer's qualifications to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Composite Panel System Manufacturer's Certificates of Compliance:
 - a. Submit the composite panel system manufacturer's Certificates of Compliance, signed by the composite panel system manufacturer, and certifying that the composite panel system materials and finishes being provided comply with the specified requirements, to the Program/Project Manager for approval.
 - 1) Provide evidence of the complete composite panel system's compliance with the specified performance requirements.
- D. Site Samples:
 - 1. Submit two 600mm by 600mm flat panel Samples of the composite panel materials showing the methods of attachment, interconnection methods, and the specified factory-applied finishes to the Program/Project Manager for approval and color verification.
 - a. If more than 2 color finishes are required, submit additional color Samples for verification.
- E. Mock-Ups:
 - 1. After the Samples have been approved, build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.
 - a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. Build composite panel mockups that include the composite panels, structural support members, fasteners, flashing and trim, and sealants matching the systems, and using the methods to be used to install production Work.
 - 2. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Protect composite panel materials from the elements and construction activity during transit and at the Site.
- B. Storage and Handling Requirements:
 - 1. Provide the protective coverings recommended by the manufacturer to protect the metal finishes.
 - 2. Store the composite panel materials off the ground.
- C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Warrant the composite panel materials and workmanship against failures during the warranty period specified, including but not limited to the following:
 - a. Composite Panels:
 - 1) Warrant the composite panels against defective materials, defective workmanship, defective watertightness, and defective design during the warranty period within 10 years from the Date of Substantial Completion.
 - b. Architectural Fluorocarbon Coating:
 - 1) Warrant the composite panel architectural fluorocarbon coating finish against fading, chalking, yellowing, peeling, cracking, pitting, corroding or non-uniformity of color, or gloss deterioration beyond manufacturer's descriptive standards during the warranty period within 20 years from the Date of Substantial Completion.
2. Submit the written Composite Panel Warranty on the manufacturer's standard form acceptable to the Owner in which the manufacturer agrees to repair or replace components of composite panels that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 COMPOSITE PANELSYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Provide a watertight rout and return, dry composite panel system, as detailed on the Contract Drawings, and consisting of concealed dry gasketed perimeter extrusions, extruded stiffeners, gaskets, fasteners and



related flashings, sealants between jamb panels and previously installed adjacent construction, and other miscellaneous accessories required for a complete watertight installation.

- a. Caulk and seal roof portions of the system, and caulk roof panels which continue on the fascia to a point 100mm down the fascia.
 - b. Provide accessories and color coordinated copings, closures, flashings and trim as required.
2. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 3. Sustainability Requirements:
 - a. Recycled Content
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

C. Performance:

1. Structural Requirements:
 - a. Flexural, Shear, and Connection Capacities:
 - 1) Engineer the composite panels to have flexural, shear, and connection capacities derived from full scale tests performed in accordance with the Chamber Method specified in ASTM E 72.
 - 2) Determine the load/span data based on full scale testing by an independent Testing and Inspection Agency employed by the manufacturer to pretest and certify the system under the installed conditions indicated in the Contract Documents.
 - b. Wind Load:
 - 1) Provide completed panel assemblies capable of withstanding the wind load indicated on the Contract Drawings, with a deflection not greater than $L/180$ when tested in accordance with the method specified in ASTM E 330.
2. Movement:
 - a. Provide composite panels capable of expansion and contraction due to structural movement and temperature changes without detriment to their appearance or performance.
3. Environmental Requirements:
 - a. Provide composite panels complying with the following environmental requirements:
 - 1) Resistance to Air Infiltration:
 - a) Provide composite panels having a resistance to air infiltration through a side joint lap of 1.04×10^{-4} cubic meters per second-



square meter of panel area ($\text{m}^3/\text{s}\cdot\text{m}^2$) when tested in accordance with the method specified in ASTM E 283 at a static test pressure differential of 298.77 Newtons per square meter (N/m^2).

- 2) Resistance to Water infiltration:
 - a) Provide composite panels having no water leakage through panel joints when tested in accordance with the method specified in ASTM E 331 at a static test pressure differential of 574.56 Newtons per square meter (N/m^2).
4. Fire-Test-Response Characteristics:
 - a. Surface-Burning Characteristics:
 - 1) Provide composite panels complying with the following surface-burning characteristic requirements when tested in accordance with the method specified in ASTM E 84:
 - a) Flame Spread Index: 25 or less.
 - b) Smoke-Developed Index: 450 or less.
 - b. Fire Propagation Characteristics:
 - 1) Provide composite panels complying with the fire propagation acceptance criteria specified in NFPA 285 when tested in accordance with the method specified in NFPA 285.

D. Design Criteria:

1. Provide a preformed panel system which consists of composite face panels and a system of custom aluminum extrusions of the size and shape indicated on the Contract Drawings, required by the approved Shop Drawings, and that has been pretested and certified by the manufacturer under the installed conditions indicated in the Contract Documents.
 - a. Design, fabricate, assemble, and erect composite panel units to insure a weather-tight system.
 - b. Include an allowance for field adjustment and thermal movements in the panel dimensions.
2. Perimeter Extrusions:
 - a. Provide aluminum extrusions having integral weather-stripping.
 - b. Rout and return all perimeters on the composite face panels.
 - 1) "Continuous edge grip (CEG)" is unacceptable.
 - c. Protect the exposed edges of the composite face panels inside extruded aluminum pockets.
 - d. The maximum overall panel thickness, including the attachment shim space, must not exceed 50mm.
 - e. Mechanically attach the composite face panel to all perimeter extrusions.
 - f. Wet sealants are unacceptable as a substitute for dry gasketing at the metal panel joinery.
3. Stiffeners:
 - a. Provide extruded aluminum sections secured to the edge trim, and bonded to the rear face of the composite face panel with silicone.



- b. Provide stiffeners having sufficient size and strength to maintain the flatness of the panel within the specified tolerances.
 - 4. Reveals at Panels:
 - a. Size the joints between the faces of the perimeter extrusions to have a nominal dimension of 12mm.
 - 5. Flatness Criteria:
 - a. For assembled units, ensure that the panels deviate from flat no more than 3mm in 4m in any direction on the panel, non-accumulatively.
 - 6. Product Data:
 - a. Obtain the manufacturer's Product Data for the composite panels, including specifications, standard detail drawings and installation procedures.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 7. Shop Drawings:
 - a. Prepare Shop Drawings for the composite panels showing their exterior wall elevations, reflected ceiling plans, roof plans, profiles of units, the method of vertical and horizontal jointing, supports, major interfaces with adjacent materials, anchorages, trim, flashing and accessories.
 - 1) Include details of the weatherproofing at edges and terminations.
 - b. Prepare Shop Drawings showing a large scale layout of all composite panel Work to be provided under this Section.
 - c. Submit the Shop Drawings to the Program/Project Manager for approval.
- E. Materials:
 - 1. Composite Panels:
 - a. Provide composite panels consisting of 2 aluminum face sheets sandwiching a core of extruded thermoplastic, and formed in a continuous process with no glues or adhesives between dissimilar materials.
 - 1) Provide composite panels having a total composite thickness of 4.0mm.
 - b. Aluminum Face Sheets:
 - 1) Provide aluminum face sheets consisting of 0.5mm thick aluminum alloy 3003 for coil coating, and that have their exterior surfaces finished.
 - a) For the exterior sheet surface finish, provide a 0.04mm thick fluoropolymer coating having 70 percent polyvinylidene fluoride (PVDF) resins, and the color specified in Section 09961, Fluoropolymer Coatings.
 - b) For the interior sheet surface finish, provide a 0.02mm thick coating of polyester.
 - 2) Provide strippable protective film, factory-applied on the exterior face, to be removed immediately after installation.



- c. Aluminum Extrusions:
 - 1) Provide extruded aluminum mounting and indexing extrusions shop-fastened to the composite panel.
 - 2) Provide extruded aluminum reveals and trim as required to conform to the design.
 - 3) Attach stiffeners in a manner that will not interfere with or restrain the free differential thermal movement of the panel.
 - a) Space the stiffeners so the panel deflection of the shortest panel dimension is limited to $L/60$.
 - d. Flashing and Trim:
 - 1) Aluminum Flashing and Trim:
 - a) Provide aluminum having of the alloy and temper recommended by the aluminum producer and finisher for the application and the finish indicated in the Contract Documents, and having at least the strength and durability of the following alloys and tempers:
 - (1) Factory-Painted Aluminum Sheet:
 - (a) Unless otherwise indicated in the Contract Documents, provide aluminum complying with the requirements for alloy 3003-H14 specified in ASTM B 209M, and having a minimum thickness of 1.0mm.
 - (2) Extruded Aluminum:
 - (a) Unless otherwise indicated in the Contract Documents, provide anodized aluminum complying with the requirements for alloy 6063-T52 specified in ASTM B 221M, and having a minimum thickness of 1.0mm for the primary legs of extrusions.
 - 2) Miscellaneous Shapes:
 - a) For coping, the bottom of walls, reveals, corners, and openings, provide extruded or sheet metal shapes finished to match the wall panels.
 - e. Manufacturer List:
 - 1) Alcan, Inc., Alucobond®, <http://www.alucobondusa.com>.
 - 2) Mitsubishi Chemical America, Inc., Alpolc, <http://www.alpolc-usa.com>.
 - 3) Alcoa, Inc., Renobond, http://www.alcoa.com/aap/north_america/en/home.asp.
 - 4) Approved equal.
2. Underlayment:
- a. Provide underlayment complying with the requirements specified in Section 07275, Fluid-Applied Membrane Air Barriers.

F. Fabrication:

- 1. Shop Fabrication:



- a. Using composite aluminum panel material and perimeter extrusions, fabricate panels of the sizes shown in the Contract Drawings and so the panel thickness at the joinery is no more than 50mm.
 - 1) Properly design and fabricate the completed panels so no restraints are placed on the panel which might result in excessive compressive skin stresses.
 - a) Oil canning of the panel surfaces is unacceptable.
 - 2) Detail the panel installation so the installed panels will remain flat when subjected to temperature changes, and remain water tight and airtight.
 - b. Provide composite panels that comply with the dimensions, profile limitations, gauges and fabrication details shown on the Contract Drawings.
 - 1) Where the dimensions, profile limitations, gauges, and fabrication details are not indicated on the Contract Drawings, provide the composite panel manufacturer's standard fabrication and details.
 - c. Rout and Return Panels:
 - 1) Reinforce rout and return panels with concealed stiffeners and anchors.
 - a) Provide stiffeners secured to the rear face of the composite panels and mechanically fastened to edge trim members at the spacing required by the specific wind loading specified.
 - 2) After routing, the sides of the groove must not touch.
 - d. Where practical, shop-fabricate composite panel units that are ready for erection.
 - 1) If the units are not shop-assembled, pre-fabricate the components at the shop as required for proper and expeditious field assembly.
 - e. Where the Contract Drawings indicate curved panels, factory-curve the panels to the required radii.
 - 1) Factory-stretch form extrusions to conform to the required panel curve.
2. Fabrication Tolerances:
- a. Surface Flatness:
 - 1) Ensure that panel bow does not exceed 0.8 percent of the panel overall dimension in width or length.
 - 2) Fabricate panels so the deviation in flatness does not exceed 0.14mm per meter in any direction when measured with a metal straight edge.
 - a) Panels exhibiting rippling, waving, or oil canning exceeding 0.14mm per meter will be rejected.
 - b. Permissible Dimensional Variations:
 - 1) Panel Width: Plus or minus 0.8mm.
 - 2) Panel Length: Plus 0mm, minus 3mm.
 - 3) Panel Thickness: Plus or minus 0.8mm.

G. Finishes:



1. Finish Materials:
 - a. Aluminum Finishes:
 - 1) Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes and application recommendations in AA DAF-45.
 - b. High-Performance Organic Coating Finish:
 - 1) Provide a high-performance organic coating finish complying with the requirements for AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating) specified in AA DAF-45.
 - 2) Organic Coating:
 - a) Provide a fluoropolymer 3-Coat "XL" coating system.
 - b) Provide the finish and custom color as specified in Section 09961, Fluoropolymer Coatings.
2. Shop Finishing Methods:
 - a. Aluminum Extrusions:
 - 1) Mill finish the extrusions not exposed to view.
 - 2) Finish the exposed extrusions to match the panel face.
 - b. Flashing and Trim:
 - 1) Finish the flashing and trim to match the adjoining panels.
 - c. High-Performance Organic Coating Finish:
 - 1) Prepare, pretreat, and apply the organic coating to the exposed metal surfaces in accordance with the coating and resin manufacturer's instructions.

2.02 ACCESSORIES

- A. Fasteners:
 1. Provide number 14 self-tapping hex head type fasteners as required for proper erection of side lap joints in concealed locations, and hot-dipped galvanized or cadmium plated screws, clips, and fasteners as recommended by the composite panel manufacturer.
- B. Gaskets:
 1. Provide dense compression gaskets molded or extruded from the following elastomeric materials to the profile and hardness required to maintain a watertight seal, and that comply with the standard referenced with the elastomer:
 - a. Provide neoprene gaskets complying with the requirements specified in ASTM C 864.
 - b. Provide ethylene propylene diene terpolymer M-class rubber (EPDM) gaskets complying with the requirements specified in ASTM C 864.
 - c. Provide silicone gaskets complying with the requirements specified in ASTM C 1115.



- C. Sealants:
 - 1. Provide medium modulus silicone sealants as specified in Section 07920, Joint Sealants.
 - 2. Compatibility Testing:
 - a. Test sealants for compatibility with substrates in accordance with the requirements specified in Section 07920, Joint Sealants.
- D. Wall Panel Support System:
 - 1. Provide framing for the wall panel support system as specified in Section 05120, Structural Steel, and Section 05400, Cold-Formed Metal Framing; and provide gypsum sheathing for the wall panel support system as specified in Section 09253, Gypsum Sheathing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the building is ready for the installation of the composite panels.
 - a. Examine the supporting members to verify the layout and alignment are correct.
 - b. Using laser instruments, field-check the dimensions and the alignment of supports.
 - 1) Verify that support members have been installed within 6mm of their theoretical location.
 - 2) The offset between any 2 adjacent members may not exceed 3mm.
 - c. Verify that structural supports are in place.
 - 1) Before installing the Work of this Section, tighten the sag rods, diagonal bracing, and connections.
- B. Evaluation and Assessment:
 - 1. Do not proceed installing the composite panels until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the composite panels.
- B. Surface Preparation:
 - 1. Isolate aluminum members from contact with concrete or dissimilar metals using neoprene shims/spacers.
 - a. Where shims/spacers are not appropriate, provide a heavy coating of bituminous paint or zinc chromate primer to concealed surfaces.



C. Demolition/Removal:

1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

A. Comply with the composite panel manufacturer's instructions for assembly, installation, and erection of the composite panels, and install the composite panels in accordance with the approved Shop Drawings.

1. Submit the composite panel manufacturer's written installation instructions to the Program/Project Manager for information.
2. Anchor component parts securely in place using concealed fasteners, and to allow for thermal and structural movement of the panels.
3. Shim the composite panels as required to erect the Work plumb, level, and true to line within a tolerance of 3mm in 1m horizontally or vertically, non-cumulative.
4. Ensure that panel lines, breaks, and curves are sharp, smooth, and free of warps and buckles.

B. Install sealants in accordance with the sealant manufacturer's instructions, including requirements for substrate priming as applicable.

1. Submit the sealant manufacturer's written installation instructions to the Program/Project Manager for information.
2. Comply with the sealant manufacturer's joint width to depth ratios.

3.04 REPAIR/RESTORATION

A. Replace damaged panels and other components of the Work which cannot be repaired by finish touch-up or similar minor repair to the Program/Project Manager and Owner's satisfaction.

1. Replace damaged work that cannot be restored to its original condition with new undamaged materials.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the composite panels are being assembled, erected, and installed, the Testing and Inspection Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.



- c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Water-Spray Test:
 - a. Test Procedure:
 - 1) After completion of the composite panel installation, the Testing and Inspection Agency will test the composite panel assembly in accordance with the methods specified in AAMA 501.2 for water penetration of each end to end splice joint, corners, and joints with door frames.
 - 2) The Program/Project Manager will select 10 locations for the testing.
 - b. Acceptance Criteria:
 - 1) Assemblies that do not leak in accordance with the requirements specified in AAMA 501.2 pass the Water-Spray Test.
- B. Non-Conforming Work
 - 1. Remove damaged materials from the Site, and replace the removed materials with new materials.
 - 2. Remove composite panels where inspections indicate they do not comply with the specified requirements, and replace the removed materials with new conforming materials.
 - a. To determine compliance of replaced or additional Work with the specified requirements, additional tests and inspections will be performed at the Contractor's expense.
- C. Manufacturer Services:
 - 1. Manufacturer's Field Service:
 - a. Engage a factory-authorized service representative to inspect the completed wall panel installation, including accessories.
 - b. Have the factory-authorized service representative submit a report of the results of the inspection in writing to the Program/Project Manager for information.

3.06 CLEANING

- A. Remove the strippable protective film from the exterior panel skins immediately after installation of each panel.
- B. Clean the exposed surfaces of the Work promptly after installation is completed .
- C. Wash the panels in accordance with the manufacturer's recommendations.
 - 1. Submit the manufacturer's written recommendations for cleaning the composite panels to the Program/Project Manager for information.



- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Train the Owner's maintenance personnel to properly clean the composite panels.

3.08 PROTECTION

- A. Protect the Work as required to ensure the composite panels will be without damage at the time of Final Acceptance.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit maintenance instructions for the composite panel finishes to the Program/Project Manager for inclusion in Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 07485

EXTERIOR WALL ASSEMBLY TESTING REQUIREMENTS

PART 1 GENERAL



Stations UCW Test
Methods, Reports and
Spec Edit



ACM Performance Test
Report

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for constructing mock-ups of exterior wall assemblies, and for performing both laboratory testing of the exterior wall assembly mock-up in a custom designed test chamber and field testing the exterior wall assembly mock-ups at the Site.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01454 – Mockup Requirements.

1.02 REFERENCES

- A. Definitions:
 - 1. Leakage Failure: the condition existing when visible water is beyond the second line of defense.
 - a. No uncontrolled water penetration may occur when the Work is tested in accordance with ASTM E 331 at pressure differentials indicated.
- B. Reference Standards:
 - 1. American Architectural Manufacturer's Association (AAMA):
 - a. AAMA 501 - Methods of Test for Exterior Walls.
 - b. AAMA 501.2 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
 - c. AAMA 501.3 - Field Check of Water and Air Leakage Through Installed Exterior Windows, Curtain Walls and Doors by Uniform Air Pressure Difference [withdrawn].
 - d. AAMA 502 - Voluntary Specification for Field Testing of Newly Installed Fenestration Products.
 - e. AAMA 503 – Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
 - 2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 3. American Society for Testing and Materials (ASTM):



- a. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- b. ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- c. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- d. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- e. ASTM E 548 – Standard Guide for General Criteria Used for Evaluating Laboratory Competence [*withdrawn*].
- f. ASTM E 1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and/or perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City of Phoenix, prior to incorporating items requiring testing by them into the Work.
 - a. Notify the Program/Project Manager 7 days in advance of the dates and times when the exterior wall assemblies will be tested
 - 2. Coordinate construction of the exterior wall assembly mock-ups with the building trades responsible for fabrication of the complete exterior wall assembly.
 - a. Construct the mock-ups in accordance with the requirements specified for the completed, in-place exterior wall assembly.
 - b. Requirements for the construction of each component of the exterior wall assembly are specified in the respective Sections.
- B. Pre-Installation Meetings:
 - 1. Pretesting Conference:
 - a. Schedule and conduct pretesting conferences at both the Testing and Inspection Agency's testing laboratory prior to performing offsite laboratory testing, and at the Site prior to performing field testing.



C. Sequencing:

1. Sequence construction activities to accommodate the required quality assurance and quality control services to minimize delays, and to avoid the necessity of removing and replacing equipment and materials to accommodate the testing and inspections.

D. Scheduling:

1. Schedule the mock-up testing so construction delays are avoided.
 - a. Schedule the times for the tests, inspections, obtaining samples, and similar activities.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Products to be used to construct mock-ups.
 - b. Shop Drawings:
 - 1) Drawings detailing the fabrication and assembly of the mock-ups to be used for laboratory testing.
 - c. Special Procedure Submittals:
 - 1) Exterior Wall Assembly Testing Protocol.
 - d. Qualification Statements:
 - 1) Exterior wall assembly Testing and Inspection Agency's qualifications.
 - 2) Professional Engineer's credentials.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Site Quality Control Submittals:
 - 1) Quality Control Test Report for the Glazing Demonstration.
 - 2) Quality Control Test Report for the Static Air Infiltration Test.
 - 3) Quality Control Test Report for the Water Penetration Tests.
 - 4) Quality Control Test Report for the Structural Tests.
 - 5) Quality Control Test Report for the Uniform Air Pressure Difference Test (Chamber Test).
 - 6) Quality Control Test Report for the Water Penetration Test (Hose Test).
 - 7) Quality Control Test Report for the Flashing Testing.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Obtain the necessary approvals for the mock-ups from the Authorities Having Jurisdiction (AHJ).
- B. Qualifications:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Testing and Inspection Agency:
 - a. To perform exterior wall assembly testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, employ an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
 - 1) The Testing and Inspection Agency must be acceptable to and approved by the Owner, and be authorized by the Authorities Having Jurisdiction to operate in the Site's geographic location.
 - 2) The Testing and Inspection Agency must be accredited to perform the tests and inspections specified in accordance with the requirements specified in ASTM E 329, and to report on and to interpret the results of those tests or inspections.
 - 3) Unless other accreditation is specified in the applicable individual Sections, each Testing and Inspection Agency must be pre-qualified in accordance with the requirements specified in ASTM E 548 to have the specialized experience and capability to conduct the testing and inspections indicated to be performed.
 - 4) Mock-Up Test Chamber:
 - a) The Testing and Inspection Agency must have a test chamber of the proper size and configuration to accommodate the mock-up test assembly.
 - (1) Construct an air chamber or enclosure having a sufficient number of observation ports sized to permit thorough examination of the interior surfaces and joints of a test assembly during actual test periods.
 - (a) Provide convenient access to the ports.



- (b) Do not place mock-up chamber supports or framing elements that are not functional or representative of actual Site conditions within chamber.
 - (c) Make the interior of the air chamber accessible so that close inspections of the test assembly can be conducted during and following water penetration and structural performance tests.
 - (2) Maintain the interior environment of the chamber at a uniform temperature of 70 degrees Fahrenheit with relative humidity of 40 percent during testing.
 - (3) Provide lighting within the test chamber to allow complete observation of the test assembly.
 - (4) The mock-up test chamber must be capable of sustaining positive and negative static pressures of at least 100 pounds per square foot.
- b) The chamber, air supply generator, and water supply must be sufficient meet the requirements for each test conducted.
- b. Submit the exterior wall assembly Testing and Inspection Agency's qualifications to the Program/Project Manager for approval.
- 3. Professional Engineer Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform structural analysis required for the structural systems.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.

C. Mock-Ups:

- 1. Assembly of Exterior Wall Assembly Mock-Ups for Laboratory Testing:
 - a. Provide mock-ups suitable for the Program/Project Manager's visual examination, and for testing to determine compliance with the performance requirements.
 - 1) Fabricate the exterior wall mock-up for laboratory testing in accordance with the reviewed and approved component and assembly mock-up Shop Drawings.
 - a) The exact configuration of the mock-up will be determined as a function of the final design of the Work, and during Shop Drawing review.
 - 2) Employing the same personnel who will fabricate, assemble, and erect the mock-ups at the Site, construct a complete exterior wall test assembly consisting of, but not limited to, the supporting framework, cold-formed metal framing, corners, splice joints, gypsum sheathing, self-adhering sheet waterproofing, sheet metal flashing and trim, architectural composite metal panel system, glazed aluminum curtain wall system, glazing, windows, coping, joint sealants, anchors, finishes, other construction indicated, and appurtenant structural elements required for support during tests



- in the Testing and Inspection Agency's custom designed test chamber.
- a) The mock-up may be glazed, plastered, and sealed at the laboratory testing facility provided such work is performed in a manner comparable to and by same persons who will perform this Work at the Site.
 - 3) Ensure that the details are complete and identical to those proposed for use in the completed construction at the Site.
 - a) Do not use an excessive amount of sealant or employ other special measures or techniques that are not representative of those to be used in the completed building at the Site.
 - 4) Finish the exterior wall assembly components to show the maximum variation between adjacent and non-adjacent components that will exist in the completed building construction.
 - b. For each exterior wall system, provide a mock-up that is a minimum of one bay wide by two stories high, unless the size and extent of the mock-up is indicated otherwise on the Contract Drawings or this is of insufficient size and configuration to adequately demonstrate the performance capabilities of the various types of Work.
 - 1) Use materials, fabrication methods, and installation methods identical to those indicated for the production Work.
 - 2) Provide full size parts for the metal assemblies, composite wall panels, glass, glazing materials, structural supports and connections, interior and exterior finish materials, sealants, insulation, and gaskets for the mock-ups using the same materials as those to be provided in the actual building.
 - 3) Extend steel reinforcing and bracing to simulate actual construction.
 - 4) Metal panels, fascias, and other sheet, plate, or laminated sheet items must read as flat and free of bow or "oil canning", and be free of "read through" of their stiffeners when installed on the building.
 - c. Construct mock-ups in accordance with the requirements specified in the Contract Documents from completely detailed drawings incorporating architectural and structural features, including details and methods of construction.
 - 1) Include mock-up components of both vertical and corner wall sections, including insulation, glazing, metal panels and coping.
 - 2) Include all of the types of glass units specified for the mock-up.
 - d. The Contractor's supervisory personnel who are responsible to construct the in-place exterior wall assembly at the Site must be present during construction of the mock-up test assembly to assist with the construction, verify that critical design details are properly reproduced, and to become familiar with the actual construction procedures.



- 1) Fabricate and erect each mock-up under the manufacturer's/installer's direct supervision, and employ workers as they would be employed during the actual erection at the Site.
- 2) Employ the same supervisory personnel who will perform Site erection.
- e. Assembly Tolerances:
 - 1) Flatness of Panels:
 - a) Assemble exposed metal faces so when they are supported in the building the maximum bow in 2 feet does not exceed 1/16 inch, and the maximum overall variation in plane between the high and low point within a panel does not exceed 1/8 inch.
2. Assembly of Exterior Wall Assembly Mock-Ups for Field Testing:
 - a. Build onsite mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver the materials for the mock-ups in accordance with the delivery and acceptance requirements specified in the Sections where the items are specified.
- B. Storage and Handling Requirements:
 1. Store and handle the materials for the mock-ups in accordance with the delivery and acceptance requirements specified in the Sections where the items are specified.
- C. Packaging Waste Management:
 1. Remove shipping, blocking, and bracing materials.
 - a. Remove loose packing materials.
 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Weather Limitations:
 - a. Proceed only when existing and forecasted weather conditions permit testing to be performed in accordance with the requirements specified in the referenced standards.

PART 2 PRODUCTS

2.01 EXTERIOR WALL ASSEMBLY TESTING REQUIREMENTS

- A. Description:



1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- B. Performance
 1. Structural Performance:
 - a. Structural performance requirements for the components within the exterior wall systems are specified in other Sections.
 2. Seismic Performance:
 - a. Seismic performance requirements for the components within the exterior wall systems are specified in other Sections.
 3. Thermal Movements:
 - a. Thermal movement requirements for components within the exterior wall systems are specified in other Sections.
- C. Design Criteria:
 1. Thermal Tolerance:
 - a. Design, fabricate, and install exterior wall systems to allow for expansion and/or contraction caused by an exterior ambient temperature ranging from minus 0 degrees Fahrenheit to an exterior metal surface temperature of 160 degrees Fahrenheit without causing harmful buckling, opening of joints, undue stress of fastenings, or other detrimental effects.
 2. Product Data:
 - a. Obtain Product Data for the products to be used to construct the mock-ups, including details, material descriptions, components, and equipment used in testing the exterior wall systems.
 - b. Submit the Product Data of the mock-ups to the Program/Project Manager for approval.
 3. Shop Drawings:
 - a. Develop Shop Drawings detailing the fabrication and assembly of the mock-ups to be used for laboratory testing, prepared by or under the supervision of a qualified Professional Engineer.
 - 1) Submit the Shop Drawings of the assembly mock-ups to the Program/Project Manager for approval.
 - 2) Resubmit revised Shop Drawings showing modifications made to mock-up as necessary for the mock-ups to pass the performance tests.
 4. Testing Protocol:
 - a. Develop the testing protocol, including descriptions of the methodology and testing procedures.
 - b. Submit the Exterior Wall Assembly Testing Protocol to the Program/Project Manager for approval.



D. Materials:

1. For the materials and products required to construct the exterior wall assembly mock-ups, refer to the individual Specification Sections where the mock-ups are specified.
 - a. Only incorporate materials into the mockups that are identical in characteristics, profile, color, texture, and finish to those to be used in construction of the production Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Prior to starting Work on mock-ups at the Site, visit the Site together with the mock-up installers to become familiarized with the conditions and related Work at the Site.

B. Evaluation and Assessment:

1. Proceed to install the mock-ups only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation and testing of the exterior wall assembly mock-ups.

3.03 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when each exterior wall assembly is being tested the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for the quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to the failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.



2. Cooperate with the agencies performing the required tests, inspections, and similar quality-control services; and provide reasonable auxiliary services as requested.
 - a. Provide the agencies performing the required tests with access to the Work.
 - b. Furnish incidental equipment, labor, and facilities necessary to facilitate the tests and inspections.
 - c. Provide security and protection for the testing and inspecting equipment at the Site.
 - d. The Program/Project Manager retains the right to check the testing technician's procedures, techniques, and other items pertinent to the testing for compliance with the standards specified.
3. Testing and Inspection Agency's Responsibility:
 - a. The Testing and Inspection Agency is responsible for testing the exterior wall systems for compliance with the specified performance requirements using the specified test methods.
 - 1) Testing agencies may not release, revoke, alter, or increase the requirements of the Contract Documents, or approve or accept any portion of the Work.
 - 2) The extent of the exterior enclosure areas to be tested is indicated in the Contract Drawings.
 - b. Test Locations:
 - 1) The Testing and Inspection Agency is responsible for performing the following exterior wall inspections and tests at the following locations indicated for the particular testing:
 - a) Testing and Inspection Agency's independent laboratory Site:
 - (1) Glazing Demonstration.
 - (2) Static Air Infiltration Test.
 - (3) Water Penetration Tests.
 - (4) Structural Tests.
 - b) Onsite Exterior Wall Mockup Field Testing:
 - (1) Uniform Air Pressure Difference Test (Chamber Test).
 - (2) Water Penetration Test (Hose Test).
 - (3) Flashing Testing.
 - c. Quality Control Test Reports:
 - 1) The Testing and Inspection Agency is responsible for preparing Quality Control Test Reports that report the results of the exterior wall system testing to show that the system complies with the requirements for the comprehensive tests of the manufacturer's current system, and that include the following information:
 - a) Date of issue.
 - b) Project title and number.
 - c) Name, address, and telephone number of the testing agency.
 - d) Dates and locations of the tests or inspections.
 - e) Names of individuals performing the tests and inspections.



- f) Description of the Work, and the test and inspection method.
 - g) Identification of the product and Specification Section.
 - h) Complete test or inspection data.
 - i) Test and inspection results, and an interpretation of the test results.
 - j) Ambient conditions at the time of the testing and inspecting.
 - k) Comments or professional opinions on whether the tested or inspected Work complies with the Contract Document requirements.
 - l) Name and signature of the laboratory inspector.
 - m) Recommendations regarding retesting and re-inspecting.
 - 2) Submit copies of each written test report directly to the Program/Project Manager.
- 4. Tests and Test Sequence for Laboratory Testing:
 - a. Glazing Demonstration:
 - 1) Remove and re-glaze selected glass lites, using the details and procedures intended for glass replacement on the actual building.
 - 2) The sealant used for the re-glazed lites may be fast curing if this does not compromise the ability of the re-glazed lites to satisfy the test criteria.
 - b. Static Air Infiltration Test:
 - 1) Test Procedure:
 - a) Pressure Preload:
 - (1) Preload the exterior wall system mock-up within the mock-up test chamber to 50 percent of the inward system design wind pressure.
 - b) Calibrate the test chamber, and perform the static air infiltration testing in accordance with the methods specified in ASTM E 283 and in the Sections requiring the mock-up testing.
 - 2) Acceptance Criteria:
 - a) Exterior wall assemblies complying with the static air infiltration performance requirements specified in the Sections requiring the exterior wall system mock-up testing pass the Static Air Infiltration Test.
 - c. Water Penetration Tests:
 - 1) Test Procedure:
 - a) Static Water Penetration Test:
 - (1) Perform the static water penetration testing in accordance with the methods specified in ASTM E 331 and in the Sections requiring the exterior wall system mock-up testing.
 - b) Dynamic Water Penetration Test:
 - (1) Perform the dynamic water penetration testing in accordance with the methods specified in AAMA 501 and



in the Sections requiring the exterior wall system mock-up testing.

- 2) Acceptance Criteria:
 - a) Exterior wall assemblies complying with the water penetration performance requirements specified in the Sections requiring the mock-up testing pass the Water Penetration Test.
- d. Structural Tests:
 - 1) Test Procedure:
 - a) Uniform Load Deflection Test:
 - (1) Perform the uniform load deflection testing at design loads specified in the Sections requiring the exterior wall system mock-up testing in accordance with the methods specified in ASTM E 330.
 - (a) Maintain the design loads for minimum 60 seconds.
 - b) Repeat the Air Infiltration Test.
 - c) Repeat the Static Water Infiltration Test.
 - d) Seismic Loading (Racking) Test:
 - (1) Test Procedure:
 - (a) Seismic performance requirements for the exterior wall systems are specified in the Sections requiring the mock-up testing.
 - (b) Move through 3 complete cycles parallel to wall, with each cycle consisting of movement from vertical to the maximum displacement in each direction and back to vertical.
 - (c) Move through 3 complete cycles normal to wall, with each cycle consisting of movement from vertical to the maximum displacement in each direction and back to vertical.
 - (2) Acceptance Criteria:
 - (a) No failure or deterioration of any kind may occur in the exterior wall system during the Structural Tests, including glass-to-metal contact.
 - e) Repeat the Air Infiltration Test.
 - f) Repeat the Static Water Penetration Test.
 - g) Wind Load Safety Factor Test:
 - (1) Test Procedure:
 - (a) Perform the Wind Load Safety Factor Test for 10 seconds in accordance with the methods specified in ASTM E 330 using a load that is 1.5 times the design load.
 - (2) Acceptance Criteria:
 - (a) Exterior wall assemblies exhibiting no glass breakage; no permanent damage to the framing members, fasteners, or anchors; and no permanent deformation



of the framing members greater than 0.2 percent of the member's clear span pass the Wind Load Safety Factor Test.

- h) Upon completion of Wind Load Safety Factor Test, inspect the silicone seals for loss of bond at a test pressure differential determined by the Testing and Inspection Agency laboratory personnel, but not less than negative 20 pounds force per square foot.
 - i) Repeat the Seismic Loading (Racking) Test using each of the following values and configurations:
 - (1) At 200 percent of the stated values parallel to the plane of the wall.
 - (2) At 200 percent of the stated values normal to the plane of the wall.
 - j) At the conclusion of this repeated Seismic Loading (Racking) Testing, gaskets may disengage and sealants may split or lose adhesion, but no other failure or deterioration of any kind may occur, including glass to metal contact, for the test specimen to pass the testing.
5. Uniform Air Pressure Difference Test (Chamber Test):
- a. Test Procedure:
 - 1) Window Walls:
 - a) The Program/Project Manager will select the test areas which will encompass 1 full typical bay width by 1 floor height at 1 location.
 - b) Test window walls in accordance with the test methods specified in AAMA 503, and perform the Water Penetration Test on the window walls in accordance with the test methods specified in ASTM E 1105.
 - (1) Use a differential of 15 pounds per square foot.
 - 2) Windows:
 - a) The Program/Project Manager will select the test areas which will encompass 1 full typical bay width by 1 floor height at 1 location for each window system.
 - b) Test windows in accordance with the test methods specified in AAMA 502, and perform the Water Penetration Test on the windows in accordance with the test methods specified in ASTM E 1105.
 - (1) Use a differential of 15 pounds per square foot.
 - 3) Louvers:
 - a) The Program/Project Manager will select the test areas which will encompass 1 full typical bay width by 1 floor height at 1 location for each louver system.
 - b) Test louvers in accordance with the test methods specified in AAMA 501.3.



- b. Acceptance Criteria:
 - 1) Test assemblies complying with the acceptance requirements specified in the test standards pass the Uniform Air Pressure Difference Test (Chamber Test).
- 6. Water Penetration Test (Hose Test):
 - a. Test Procedure:
 - 1) The Program/Project Manager will select the test areas which will encompass 1 full typical bay width by 1 floor height at 1 location.
 - a) Except at parapets and ground floors, the test areas will be located from mid-bay to mid-bay and from mid-story-height to mid-story-height.
 - b) Limit each test area to 1 bay wide, but not less than 20 feet or more than 40 feet, by 1 story high.
 - 2) Perform the Water Penetration Test (Hose Test) in accordance with the "Field Check for Water Leakage of Metal Curtain Walls", test method specified in AAMA 501.2, except perform the test within the area specified herein.
 - b. Acceptance Criteria:
 - 1) Test assemblies complying with the acceptance requirements specified in the test standards pass the Water Penetration Test (Hose Test).
- 7. Flashing Testing:
 - a. Test Procedure:
 - 1) The Program/Project Manager will select the test areas which will encompass six 30'-0" lengths of flashing.
 - 2) End dam and plug weep holes at selected test areas.
 - 3) Selected test areas must include splices in the flashing.
 - 4) Fill the cavity 2 inches high with water.
 - 5) Conduct the test over a continuous 24-hour period, and determine if leaks exist and the volume of water loss.
 - b. Acceptance Criteria:
 - 1) Test assemblies that do not leak pass the Flashing Testing.

B. Non-Conforming Work:

- 1. Repair and modify exterior wall assemblies having leakage disclosed by tests of the Work in place, and retest the repaired and modified exterior wall assemblies.
- 2. Modify the methods of installing the Work subsequent to the testing to incorporate corrections determined to be necessary by the testing process.

3.04 CLEANING

- A. Remove rejected mock-ups from the Site after the final mock-up is approved.



- B. Demolish and remove mock-ups from the Site when requested by the Program/Project Manager.
- C. Waste Management:
 - 1. At the end of each work day, recycle or dispose of unused material, debris and containers.
 - 2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Furnish on-going care and protection for the onsite mock-ups until the date of Substantial Completion so they will not deteriorate or be damaged
 - 1. Remove protection at the time of Substantial Completion.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 07542

POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for an adhered PVC membrane roofing system.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. PVC: Polyvinyl-chloride.
 - 3. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
 - 4. SRI: Solar reflective index.
 - 5. UL: Underwriters Laboratories, Inc.
 - 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.



- b. ASTM D 4434 - Standard Specification for Poly(Vinyl Chloride) Sheet Roofing.
- c. ASTM D 5036 - Standard Practice for Application of Adhered Poly(Vinyl Chloride) Sheet Roofing.
- d. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
- e. ASTM E 1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. FM Approvals LLC (FM):
 - a. FM Class Number 4470 – Approval Standard for Class 1 Roof Covers.
 - b. The Approval Guide, www.approvalguide.com.
- 4. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 5. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 6. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Conduct a Pre-Installation Roofing Conference one week before starting the Work of this Section at the Site.
 - a. Review preparation and installation procedures, and coordination and scheduling required with related work.

1.04 SUBMITTALS

- A. Action Submittals: Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Polyvinyl-chloride (PVC) sheet membrane.
 - 2) Walkway membrane.
 - 3) Roofing insulation.
 - 4) Bonding adhesive.
 - 5) Metal termination bars.
 - 6) Sheet flashing.
 - 7) Sheet membrane fasteners.
 - 8) Miscellaneous accessories.
 - b. Shop Drawings:



- 1) Polyvinyl-chloride (PVC) roofing system.
 - c. Samples:
 - 1) Sheet roofing verification Samples.
 - d. Certificates:
 - 1) Manufacturer's Certificates.
 - e. Qualification Statements:
 - 1) Installer qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Roofing system manufacturer's written instructions for installing the roofing system.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - 1) Heat Island Effect: Roof, Submittal for the polyvinyl-chloride (PVC) roofing system.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance data for the roofing system.
 - b. Warranty Documentation:
 - 1) Polyvinyl-Chloride (PVC) Roofing Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Installer's Qualifications:
 - a. Engage a qualified firm that is approved, authorized, and/or licensed by the membrane roofing system manufacturer to install the manufacturer's product.



- b. Submit the installer's qualifications to the Program/Project Manager for approval.
 - C. Certifications:
 - 1. Manufacturer's Certificates:
 - a. Submit Manufacturer Certificates, signed by the roofing manufacturer, certifying that the roofing system being provided complies with the specified requirements.
 - 1) Provide evidence of the complete roofing system's compliance with the specified performance requirements.
 - D. Site Samples:
 - 1. Verification Samples:
 - a. Submit the sheet roofing verification Samples of the color specified or indicated on the Contract Drawings.

1.06 WARRANTY

- A. Special Warranty:
 - 1. Warrant the polyvinyl-chloride (PVC) roofing materials and workmanship against failures within the 30-year period after the Date of Substantial Completion:
 - 2. Submit a written Polyvinyl-Chloride (PVC) Roofing Warranty on the manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of the roofing system that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain polyvinyl-chloride (PVC) roofing and accessories from a single source from single manufacturer.
- B. Sustainability Requirements:
 - 1. Heat-Island Roof



- a. Provide roofing having a Solar reflective index (SRI) complying with the following requirements:
 - 1) For roof slopes less than 2:12: Greater than or equal to 78.
 - 2) For roof slopes greater than or equal to 2:12: 29.
 - b. Provide materials not exceeding the following volatile organic compound (VOC) limits:
 - 1) For board insulation adhesive: 250 gallons per Liter.
- C. Performance:
 - 1. Energy Performance:
 - a. Provide a roofing system with an initial Solar Reflectance Index (SRI) not less than 78 when calculated according to ASTM E 1980, as determined by a qualified testing agency, such as UL, testing identical products.
 - 2. Exterior Fire-Test Exposure:
 - a. Provide a roofing system complying with the requirements for Class A exterior fire-test exposure as specified in ASTM E 108 for the application and roof slopes indicated on the Contract Drawings, as determined by a qualified testing agency, such as UL, testing identical membrane roofing materials.
 - b. Identify materials with the appropriate markings of the applicable testing agency.
- D. Design Criteria:
 - 1. Obtain components for the membrane roofing system only as approved by the membrane roofing manufacturer.
 - 2. Product Data:
 - a. Submit the manufacturer's Product Data for each type of product indicated and provided.
 - 3. Shop Drawings:
 - a. Submit Shop Drawings for the polyvinyl-chloride (PVC) roofing system, including plans, elevations, sections, details, and attachments to other work.
- E. Materials:
 - 1. Polyvinyl-Chloride (PVC) Sheet Membrane:
 - a. Provide glass fiber reinforced, felt backed polyvinyl-chloride (PVC) sheet membrane complying with the requirements for Type II, Grade I as specified in ASTM D 4434.
 - b. Nominal Thickness: 72 mils.
 - c. Exposed Face Color: Beige.
 - d. Manufacturers:
 - 1) Sika Sarnafil Inc., Sarnafil G410, www.sarnafilus.com.
 - 2) Approved equal.
 - 2. Walkway Membrane:



- a. Provide a polyester reinforced, weldable membrane with surface embossment.
- b. Nominal Thickness: 96 mils.
- c. Manufacturers:
 - 1) Sika Sarnafil Inc., Sarnatred, www.sarnafilus.com.
 - 2) Approved equal.
- 3. Roofing Insulation:
 - a. Provide Type II, Class I, Grade 3 polyisocyanurate board insulation complying with the requirements specified in ASTM C 1289.
 - 1) Provide a felt or glass-fiber mat facer on both major surfaces.
 - b. Tapered Insulation:
 - 1) Provide factory-tapered insulation boards fabricated with a slope of 1/4 inch to 12 inches (1:48) unless otherwise indicated.
 - 2) Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain.
 - 3) Fabricate insulation boards having the slopes indicated on the Contract Drawings.
 - c. Board Insulation Accessories:
 - 1) Fasteners:
 - a) Provide factory coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Class Number 4470, designed for fastening roof insulation to the substrate, and acceptable to roofing system manufacturer.
 - 2) Insulation Adhesive:
 - a) Provide the insulation manufacturer's recommended cold-applied adhesive formulated to attach roof insulation to the substrate or to another insulation layer.

2.02 ACCESSORIES

- A. Bonding Adhesive:
 - 1. Provide the manufacturer's standard, water based bonding adhesive.
- B. Metal Termination Bars:
 - 1. Provide the manufacturer's standard, predrilled stainless steel or aluminum termination bars, approximately 1 inch (25mm) by 1/8 inch (3mm) thick; with anchors.
- C. Sheet Flashing:
 - 1. Provide the manufacturer's standard sheet flashing of the same material, type, reinforcement, thickness, and color as the polyvinyl-chloride (PVC) sheet membrane.
- D. Sheet Membrane Fasteners:



1. Provide factory-coated steel fasteners and metal or plastic plates designed for fastening the sheet membrane to the substrate, that comply with the corrosion-resistance provisions in FM Class Number 4470, and that are acceptable to the membrane roofing system manufacturer.

E. Miscellaneous Accessories:

1. Provide auxiliary membrane roofing materials as recommended by the roofing system manufacturer for the application indicated on the Contract Drawings, and compatible with the membrane roofing provided.
2. Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories as required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify that surfaces and Site conditions are ready to receive the Work of this Section.
 - a. Verify that the roof deck and existing roof construction is structurally sound enough to provide support for the new roof system, and secured to the structural framing.
 - b. Verify the roof insulation system has been properly installed.
 - c. Verify that insulation surfaces are dry.

3.02 INSTALLATION

A. Roofing Insulation:

1. Comply with the roofing system and insulation manufacturers' written instructions for installing roof insulation.
2. Install tapered insulation under the area of the roofing so it conforms to the slopes indicated on the Contract Drawings.
3. Install insulation under the area of the roofing so the required thickness is achieved
 - a. Where the overall insulation thickness is 2.7 inches (68mm) or greater, install 2 or more layers of insulation, and stagger the joints of each succeeding layer from the joints of the previous layer a minimum of 6 inches (150mm) in each direction.
4. Mechanically Fastened Insulation:
 - a. Install each layer of insulation, and secure it to the deck using mechanical fasteners specifically designed and sized for fastening board-type roof insulation to the deck type.
 - b. Fasten insulation to resist uplift pressure at the corners, perimeter, and the field of the roof.



B. Membrane Roofing:

1. Install roofing insulation as specified in Section 07210, Building Insulation.
2. Install the polyvinyl-chloride (PVC) membrane roofing provided according to the membrane roofing system manufacturer's written instructions.
 - a. Accurately align the membrane roofing, and maintain uniform side and end laps of the minimum dimensions required by manufacturer.
 - 1) Stagger end laps.
 - b. Submit the roofing system manufacturer's written instructions for installing the roofing system to the Program/Project Manager for information.
3. Bonding Adhesive:
 - a. Adhere the polyvinyl-chloride (PVC) membrane roofing over the area to receive the roofing according to the requirements specified in ASTM D 5036.
 - 1) Apply bonding adhesive to the substrate and underside of the membrane roofing at the rate required by the manufacturer, and allow the adhesive to partially dry before installing the membrane roofing.
 - 2) Do not apply bonding adhesive to the splice area of the membrane roofing.
4. Mechanical Fastening:
 - a. In addition to adhering the polyvinyl-chloride (PVC) roofing membrane using the bonding adhesive, mechanically fasten the membrane roofing securely at terminations, penetrations, and the perimeter of the roofing.
5. Apply membrane roofing with side laps shingled with the slope of the roof deck wherever possible.
6. Seams:
 - a. Clean seam areas, overlap the polyvinyl-chloride (PVC) membrane roofing, and hot-air weld the side and end laps of the membrane roofing and sheet flashings according to the manufacturer's written instructions to ensure a watertight seam installation.

C. Base Flashing:

1. Provide sheet flashings and preformed flashing accessories, and adhere them to the substrates according to the membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to the substrate and underside of the sheet flashing at the required rate, and allow it to partially dry.
 - a. Do not apply bonding adhesive to the seam area of the flashing.
3. Flash the penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive.
 - a. Hot-air weld the side and end laps to ensure a watertight seam installation.



5. Terminate and seal the top of sheet flashings, and mechanically anchor them to the substrate through termination bars.

3.03 REPAIR

- A. Repair tears, voids, and lapped seams in the roofing that do not comply with the requirements specified.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:

1. Site Tests:

- a. During the period when the polyvinyl-chloride (PVC) roofing system is being installed, the Testing and Inspection Agency must perform routine and other testing of materials.

- 1) Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
- 2) The Testing and Inspection Agency will perform additional materials testing due to failure of material to meet specified requirements.
- 3) Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

- b. Seam Weld Continuity Test:

- 1) Test Procedure:

- a) A minimum of twice daily, the Testing and Inspection Agency will verify the field strength of the seams.
- b) The lap edges will be tested with a probe to verify seam weld continuity.
 - (1) Repair these seam sample areas
 - (2) Apply lap sealant to seal cut edges of the sheet membrane.

- 2) Acceptance Criteria:

- a) Roofing seams that are continuous without holes or gaps are acceptable.

2. Inspections:

- a. Final Roof Inspection:

- 1) Arrange for the roofing system manufacturer's technical personnel to inspect the complete roofing installation, including roof insulation, upon its completion to verify the system is acceptable.

- B. Non-Conforming Work



1. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

C. Manufacturer Services:

1. Arrange for the roofing system manufacturer's technical personnel to be onsite for the Final Roof Inspection.

3.05 MAINTENANCE

- A. Submit maintenance data for the roofing system to the Program/Project Manager.

END OF SECTION

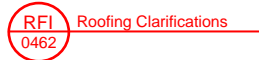
REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition
1	12/20/2017	N/A	1.02.A, 1.02.C.6, 1.04.B.2, 2.01.B	Add requirements for ENVISION Sustainability Rating System



SECTION 07551

ATACTIC POLYPROPYLENE-MODIFIED (APP-MODIFIED) BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL



APP mod bit roofing, cool
APP in lieu of torch applied
approved for use

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for atactic polypropylene-modified (APP-modified) bituminous membrane roofing and associated roof insulation.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Install acoustical roof deck rib insulation strips furnished under Section 05310, Steel Deck, as the Work of this Section.
- C. Related Requirements:
 - 1. Section 01316 – Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 05310 – Steel Deck.
 - 6. Section 06105 – Miscellaneous Carpentry.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. APP: Atactic polypropylene.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. SRI: Solar reflective index.
- B. Definitions:
 - 1. Roofing Terminology - Refer to ASTM D 1079 and the glossary of The NRCA Roofing and Waterproofing Manual for definition of terms related to the roofing work in this Section.
 - 2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.



3. Equiviscous Temperature: The temperature at which a bitumen attains the proper viscosity for built-up roofing application, in particular the temperature at which its viscosity is 125 centipoises for mop-applied roofing asphalt and 75 centipoises for mechanical spreader-applied roofing asphalt.
4. Hot Roofing Asphalt - Roofing asphalt heated to its equiviscous temperature, within a range of plus or minus 25 degrees Fahrenheit, measured at the mop cart or mechanical spreader, immediately before application.
5. SEBS-Modified Roofing Asphalt: Styrene-ethylene-butylene-styrene modified asphalt intended for use in built-up roof construction, construction of some modified bitumen systems, construction of bituminous vapor retarder systems, and for adhering insulation boards used in various types of roof systems.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM C 208 – Standard Specification for Cellulosic Fiber Insulating Board.
 - b. ASTM C 728 – Standard Specification for Perlite Thermal Insulation Board.
 - c. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - d. ASTM D 41 – Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 - e. ASTM D 312 – Standard Specification for Asphalt Used in Roofing.
 - f. ASTM D 1079 – Standard Terminology Relating to Roofing and Waterproofing.
 - g. ASTM D 3617 – Standard Practice for Sampling and Analysis of New Built-Up Roof Membranes.
 - h. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - i. ASTM D 6222 – Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
 - j. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
 - k. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. FM Approvals LLC (FM):
 - a. FM Class Number 4470 – Approval Standard for Class 1 Roof Covers.
 - b. The Approval Guide, www.approvalguide.com.
4. International Code Council (ICC):



- a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- b. ICC Evaluation Services, Inc. (ICC ES), www.icc-es.org.
- 5. National Roofing Contractors Association (NRCA):
 - a. The NRCA Roofing and Waterproofing Manual.
 - b. NRCA Quality Control Guidelines for Application of Polymer Modified Bitumen Roofing.
- 6. Underwriters Laboratories, Inc.® (UL):
 - a. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
- 7. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation of the acoustical roof deck rib insulation strips furnished under Section 05310, Steel Deck, with the Work of this Section.
- B. Pre-Installation Meetings:
 - 1. Schedule and conduct a Pre-Installation conference at the Site in accordance with the requirements specified in Section 01316, Project Meetings.
 - 2. Review the methods and procedures related to the roofing system including, but not limited to, the following:
 - a. Meet with the Owner, Program/Project Manager, Owner's insurer if applicable, Testing and Inspecting Agency representative, roofing installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects the roofing, including installers of roof accessories and roof mounted equipment.
 - b. Review the methods and procedures related to roofing installation, including the manufacturer's written instructions.
 - 1) Submit the manufacturer's written roofing installation instructions to the Program/Project Manager for information.
 - c. Review and finalize the construction schedule, and verify the availability of materials, the installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - d. Examine the deck substrate conditions and finishes for compliance with the specified requirements, including its flatness and fastening.
 - e. Review structural loading limitations of the roof deck during and after roofing.
 - f. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect the roofing system.



- g. Review the governing regulations and requirements for insurance and certificates if applicable.
- h. Review temporary protection requirements for the roofing system during and after installation.
- i. Review roof observation and repair procedures after roofing installation.

C. Sequencing:

- 1. Sequence installation of the roofing system components with installation of the roofing insulation so the insulation is not exposed to precipitation or left exposed at the end of the workday.
- 2. Install counterflashing after the roofing has been installed.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) APP-modified asphalt membrane sheet.
 - 2) APP-modified asphalt membrane cap sheet.
 - 3) Base flashing sheet.
 - 4) Asphalt primer.
 - 5) Roofing asphalt.
 - 6) Cold-applied adhesive.
 - 7) Mastic sealant.
 - 8) Roofing membrane fasteners.
 - 9) Roofing granules.
 - 10) Miscellaneous accessories as recommended by the roofing system manufacturer.
 - 11) Roof insulation.
 - 12) Roof insulation fasteners.
 - 13) Insulation cant strips.
 - 14) Wood nailer strips.
 - 15) Substrate joint tape.
 - b. Shop Drawings:
 - 1) Atactic polypropylene-modified bituminous membrane roofing system.
 - c. Samples:
 - 1) Roofing Sample.
 - 2) Walkway pad or walkway cap sheet Sample.
 - d. Certificates:
 - 1) Manufacturer Certificates.
 - e. Special Procedure Submittals:
 - 1) Written roof condition report.



- f. Qualification Statements:
 - 1) Atactic polypropylene-modified bituminous membrane roofing installer's qualifications.
 - 2) Atactic polypropylene-modified bituminous membrane roofing manufacturer's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Research/evaluation reports for the components of the roofing system.
 - b. Manufacturer's Instructions:
 - 1) Roofing installation instructions.
 - 2) Acrylic coating manufacturer's written application instructions.
 - c. Manufacturer's Reports:
 - 1) Inspection Report:
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and Maintenance manuals for the atactic polypropylene-modified bituminous membrane roofing system.
 - b. Warranty Documentation:
 - 1) Atactic Polypropylene-Modified Bituminous Membrane Roofing Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Atactic Polypropylene-Modified Bituminous Membrane Roofing Installer's Qualifications:



- a. Engage a qualified firm that is approved, authorized, and/or licensed by the membrane roofing system manufacturer to install the manufacturer's product so it is eligible to receive the manufacturer's warranty.
 - b. Submit the installer's qualifications to the Program/Project Manager for approval.
 2. Atactic Polypropylene-Modified Bituminous Membrane Roofing Manufacturer Qualifications:
 - a. Engage a qualified manufacturer providing a UL-listed roofing system identical to that to be provided under this Section.
 - b. Submit the manufacturer's qualifications, including evidence of the UL-listing for their roofing system, to the Program/Project Manager for approval.
- C. Certifications:
 1. Manufacturer's Certificates:
 - a. Submit Manufacturer Certificates, signed by the roofing manufacturer, certifying that the roofing system being provided complies with the specified requirements.
 - 1) Provide evidence of the complete roofing system's compliance with the specified performance requirements.
- D. Preconstruction Testing:
 1. Submit research/evaluation reports for the components of the roofing system, such as from ICC Evaluation Services, Inc., to the Program/Project Manager for information.
- E. Site Samples:
 1. Verification Samples:
 - a. Submit the following roofing verification Samples to the Program/Project Manager for approval:
 - 1) 12-inch by 12-inch square roofing Sample of the color specified or indicated on the Contract Drawings.
 - 2) 12-inch by 12-inch square Sample of the walkway pad or walkway cap sheet.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver roofing materials to the Site in their original containers, with their seals unbroken, labeled with the manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- B. Storage and Handling Requirements:
 1. Liquid Materials:



- a. Store liquid materials in their original undamaged containers in a clean, dry, protected location; and within the temperature range specified by the roofing system manufacturer.
 - b. Protect stored liquid material from direct sunlight.
 - c. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
 2. Roof Insulation:
 - a. Protect roof insulation materials from physical damage, and from deterioration by sunlight, moisture, soiling, and other sources.
 - b. Store the roof insulation materials in a dry location.
 - c. Comply with the insulation manufacturer's written instructions for handling, storing, and protecting the insulation.
 3. Roofing Materials:
 - a. Handle and store roofing materials, and place equipment, in a manner to avoid permanent deflection of the deck.
- C. Packaging Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Weather Limitations:
 - a. Proceed with installation only when the existing and forecasted weather conditions permit the roofing system to be installed according to the manufacturer's written instructions and warranty requirements.

1.08 WARRANTY

- A. Special Warranty:
 1. Warrant the atactic polypropylene-modified bituminous membrane roofing materials and workmanship against failures within the 25-year period after the Date of Substantial Completion:
 2. Submit a written Atactic Polypropylene-Modified Bituminous Membrane Roofing Warranty on the manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of the roofing system, including the roofing membrane, base flashings, and other components of roofing system, that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 ATACTIC POLYPROPYLENE-MODIFIED BITUMINOUS MEMBRANE ROOFING SYSTEM

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments and the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 2. Sustainability Requirements:
 - a. Heat-Island Roof
 - 1) Provide roofing having a Solar reflective index (SRI) complying with the requirements:
 - a) For roof slopes less than 2:12: Greater than or equal to 78.
 - b) For roof slopes greater than or equal to 2:12:29.
- C. Performance:
 - 1. Fire-Test-Response Characteristics:
 - a. Provide roofing materials that have the fire-test-response characteristics indicated as determined when Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), or another testing and inspecting agency acceptable to the Authorities Having Jurisdiction tests identical products in accordance with the following test methods:
 - 1) Exterior Fire-Test Exposure:
 - a) Determine the exterior fire-test exposure in accordance with the Class A Method of Test specified in ASTM E 108 for the application and roof slopes indicated in the Contract Documents.
 - 2) Fire-Resistance Ratings:
 - a) Determine the fire-resistance ratings in accordance with the methods specified in ASTM E 119 for the fire-resistance-rated roof assemblies of which the roofing system is a part.
 - b. Identify materials with appropriate markings of the applicable testing and inspecting agency.



2. Environmental Performance:
 - a. Provide installed roofing membrane and base flashings that remain watertight, that do not permit the passage of water, and that resist the specified uplift pressures, thermally induced movement, and exposure to weather without failure.
 3. Material Compatibility:
 - a. Provide roofing materials that are compatible with one another under the conditions of service and the application required, based on testing and field experience as demonstrated by the roofing manufacturer.
- D. Design Criteria:
1. Provide atactic polypropylene-modified bituminous membrane roofing system components from, or approved by, the roofing system manufacturer.
 2. Auxiliary Roofing Membrane Materials:
 - a. Provide auxiliary materials recommended by the roofing system manufacturer for the intended application, and compatible with the roofing membrane.
 3. Roof Insulation:
 - a. Provide preformed roof insulation boards complying with specified requirements and referenced standards.
 - b. Provide roof insulation boards selected from the manufacturer's standard sizes, and of the thicknesses indicated in the Contract Documents.
 4. Insulation Accessories:
 - a. Provide the roof insulation accessories recommended by the insulation manufacturer for the intended application, and compatible with the membrane roofing.
 5. Product Data:
 - a. Submit the manufacturers Product Data for each type of atactic polypropylene-modified bituminous membrane roofing product proposed for the Work of this Section to the Program/Project Manager for approval.
 6. Shop Drawings:
 - a. Submit Shop Drawings of the atactic polypropylene-modified bituminous membrane roofing system to the Program/Project Manager for approval.
 - 1) Include plans, elevations, sections, details, and attachments to other Work.
- E. Materials:
1. Atactic Polypropylene-Modified (APP-Modified) Asphalt-Sheet Materials:
 - a. Roofing Membrane Sheet:
 - 1) Provide smooth surfaced roofing membrane sheet complying with the requirements for Grade S, Type I or II, polyester-reinforced,



- APP-modified asphalt sheet specified in ASTM D 6222, and suitable for the application method specified.
- b. Roofing Membrane Cap Sheet:
 - 1) Provide smooth surfaced roofing membrane cap sheet complying with the requirements for Grade S, Type I or II, polyester-reinforced, APP-modified asphalt sheet specified in ASTM D 6222, and suitable for the application method specified.
 - c. Manufacturers:
 - 1) Firestone Building Products Company, www.firestonebpco.com.
 - 2) U.S. Intec®, Inc., a division of BMCA, www.usintec.com.
 - 3) Tremco, <http://www.tremcoroofing.com>.
 - 4) Approved equal.
2. Base Flashing Sheet Materials:
- a. Flashing Sheet:
 - 1) Provide granular surfaced flashing sheet complying with the requirements for Grade G, Type I or II, polyester-reinforced, APP-modified asphalt sheet specified in ASTM D 6222, and suitable for the application method specified.
 - a) Granule Color:
 - (1) Provide granular surfaced flashing sheet having tan colored granules.
 - b. Manufacturers:
 - 1) Firestone Building Products Company, www.firestonebpco.com.
 - 2) U.S. Intec®, Inc., a division of BMCA, www.usintec.com.
 - 3) Tremco, <http://www.tremcoroofing.com>.
 - 4) Approved equal.
3. Auxiliary Roofing Membrane Materials:
- a. Asphalt Primer:
 - 1) Provide asphalt primer complying with the requirements specified in ASTM D 41.
 - b. Roofing Asphalt:
 - 1) Provide roofing asphalt, complying with the requirements specified in ASTM D 312, and of the type recommended by the roofing system manufacturer for the application.
 - c. Cold-Applied Adhesive:
 - 1) Provide the roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with the roofing membrane and base flashings.
 - d. Mastic Sealant:
 - 1) Provide polyisobutylene, plain or modified bitumen, mastic sealant that is nonhardening, nonmigrating, nonskinning, and nondrying.
 - e. Roofing Membrane Fasteners:
 - 1) Provide factory-coated steel fasteners and metal or plastic plates complying with the corrosion-resistance provisions specified in FM



- Class Number 4470; and designed for fastening the roofing membrane components to the substrate, tested by the manufacturer for the required pullout strength, and acceptable to the roofing system manufacturer.
- f. Roofing Granules:
 - 1) Provide ceramic-coated, No. 11 screen size roofing granules.
 - 2) Provide roofing granules graded so 100 percent pass a No. 8 sieve, and 98 percent of the granules' mass is retained on a No. 40 sieve.
 - 3) Provide roofing granules having a color matching the roofing membrane.
 - g. Miscellaneous Accessories:
 - 1) Provide miscellaneous accessories as recommended by the roofing system manufacturer.
4. Roof Insulation:
- a. Polyisocyanurate Board Insulation:
 - 1) Provide polyisocyanurate board insulation complying with the requirements for Type I Class 1 insulation specified in ASTM C 1289, and having an aluminum foil facer on both major surfaces.
 - b. Tapered Insulation:
 - 1) Provide factory-tapered insulation boards fabricated to have the slope indicated.
 - c. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated on the Contract Drawings for sloping the roof to drains.
 - 1) Fabricate these preformed insulation shapes to have the slopes indicated.
 - d. Insulation Cover Board:
 - 1) Provide 0.5-inch (13mm) thick perlite insulation board having a length and other characteristics recommended by the manufacturer.
 - 2) Provide asphalt for attaching the insulation cover board to the insulation.
 - e. Manufacturers:
 - 1) Celotex Corporation, <http://www.celotex.co.uk>.
 - 2) Firestone Building Products Company, www.firestonebpco.com.
 - 3) Approved equal.
5. Coating Materials
- a. Roof Coating: remedial coating system for existing mineral surface modified bit substrates, elastomeric silicone coating.
 - b. Manufacturers: Gaco Western GacoFlex S-20 (www.gaco.com) or approved equal.



- c. Apply two coats of elastomeric silicone coating over existing built-up roof membrane at Penthouse roof. Adhesion tests will be required per ASTM D903.
- d. Roof coating: over metal roofs. Polyurethane and silicone elastomeric coating system.
- e. Manufacturers: Gaco Western GacoFlex 32 MIL (www.gaco.com) or approved equal.
- f. Base coats include two component aromatic polyurethane. Topcoat is the GacoSil S-10 silicone coating.
- g. Color to be Tan or selected from manufacturers standard color choices.
- 6. Insulation Accessories:
 - a. Roof Insulation Fasteners:
 - 1) Provide factory-coated steel fasteners and metal or plastic plates complying with the corrosion-resistance provisions specified in FM Class Number 4470, designed for fastening the roof insulation to the substrate, and acceptable to the roofing system manufacturer.
 - b. Insulation Cant Strips:
 - 1) Provide perlite insulation board cant strips complying with the requirements specified in ASTM C 728; or cellulosic-fiber insulation complying with the requirements for Type II, Grade 1 insulation board specified in ASTM C 208.
 - c. Wood Nailer Strips:
 - 1) Provide wood nailer strips complying with the requirements specified in Section 06105, Miscellaneous Carpentry.
 - d. Substrate Joint Tape:
 - 1) Provide 6-inch or 8-inch wide, coated, glass-fiber joint tape.
 - e. Roof Walkway Pads:
 - 1) Provide granule surfaced atactic polypropylene (APP) polymer-modified cap sheets, or standard 3-foot by 4-foot walk pads.
 - 2) Acrylic Coating:
 - a) Provide a white acrylic coating for the roof walkway pads.
 - b) Membrane cleaner:
 - (1) Provide the membrane cleaner recommended by the manufacturer.
 - c) Manufacturers:
 - (1) Firestone Building Products Company, LLC, AcryliTop PC-11, <http://www.firestonebpco.com>.
 - (2) Approved equal.
 - (3)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:



1. With the atactic polypropylene-modified bituminous membrane roofing installer present, examine the substrates, areas, and conditions where the roofing will be installed for compliance with the following requirements and other conditions affecting the performance of roofing system:
 - a. Verify that roof openings and penetrations are in place, set, and braced; and that roof drains are securely clamped in place.
 - b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to the roof deck at penetrations and terminations, and that nailers match the thicknesses of the insulation.
 - c. Verify that the surface plane flatness and the fastening of the steel roof deck comply with the requirements specified in Section 05310, Steel Deck.
 - d. Verify that concrete curing compounds that will impair the adhesion of the roofing components to the roof deck have been removed.
 - e. Verify that the roof deck is securely fastened, with no projecting fasteners, and with no adjacent roof deck units in excess of 1/16 inch out of plane relative to the adjoining deck.
- B. Pre-Installation Testing:
 1. Capillary Moisture Test:
 - a. Test Procedure:
 - 1) Determine the capillary moisture of the concrete substrates in accordance with the plastic sheet method specified in ASTM D 4263.
 - b. Acceptance Criteria:
 - 1) Verify that the concrete substrates are visibly dry and free of moisture.
 2. Surface Moisture Test:
 - a. Test Procedure:
 - 1) Test for moisture by pouring 1 pint of hot roofing asphalt on the deck at the start of each day's work and at the start of each roof area or plane.
 - b. Acceptance Criteria:
 - 1) Do not proceed with roofing work if the test sample foams or can be easily and cleanly stripped after cooling.
- C. Evaluation and Assessment:
 1. Proceed with installation of the roofing only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Prevent materials from entering and clogging roof drains and conductors, and from spilling or migrating onto surfaces of other construction.



- a. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- 2. Substrate-Joint Penetrations:
 - a. Prevent roofing asphalt from penetrating substrate joints, entering the building, or damaging the roofing system components or adjacent building construction.
- B. Surface Preparation:
 - 1. Clean dust, debris, moisture, and other substances detrimental to the roofing installation from the substrate in accordance with the roofing system manufacturer's written instructions.
 - 2. Prime the surface of concrete deck with asphalt primer at a rate of 3/4 gallons per 100 square feet, and allow the primer to dry before proceeding to install the roofing.
- C. Demolition/Removal:
 - 1. Remove sharp projections from the substrate.

3.03 INSTALLATION

- A. Insulation:
 - 1. Comply with roofing system manufacturer's written instructions for installing roof insulation.
 - a. Roof Deck Rib Insulation Strips:
 - 1) Install acoustical roof deck rib insulation strips, specified in Section 05310, Steel Deck, according to the acoustical roof deck manufacturer's written instructions.
 - 2. Nailer Strips:
 - a. Mechanically fasten 4-inch nominal width wood nailer strips having the same thickness as the insulation perpendicular to the sloped roof deck at the following spacing:
 - 1) For roof slopes greater than 1 inch per 12 inches, but less than 3 inches per 12 inches, space the nailer strips 16 feet apart.
 - 2) For roof slopes greater 3 inches per 12 inches, space the nailer strips 48 inches apart.
 - 3. Insulation Cant Strips:
 - a. Install and secure preformed 45-degree insulation cant strips at the junctures of the roofing membrane system with vertical surfaces or angle changes greater than 45 degrees.
 - 4. Tapered Insulation:
 - a. Install tapered insulation under the area of the roofing to conform to the slopes indicated in the Contract Documents.
 - 5. Install insulation with the long joints of the insulation in a continuous straight line, with end joints staggered between rows, abutting edges, and ends between boards.
 - a. Fill gaps exceeding 1/4 inch (6mm) with insulation.



- b. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 6. Install one or more layers of insulation under the area of the roofing to achieve the required thickness.
 - a. Where the overall insulation thickness is 2 inches or greater, install 2 or more layers with the joints of each succeeding layer staggered from the joints of the previous layer a minimum of 6 inches in each direction.
 7. Trim the surface of insulation at roof drains where necessary to ensure that the completed surface is flush and does not restrict the flow of water.
 8. Mechanically Fastened Insulation:
 - a. Install each layer of insulation, and it secure to deck using mechanical fasteners specifically designed and sized for fastening the specified board-type roof insulation to type of deck present.
 - 1) Fasten insulation to resist the uplift pressure at corners, the perimeter, and within the field of the roof.
- B. APP-Modified Bituminous Membrane:
 1. Install the modified bituminous roofing membrane system according to the roofing system manufacturer's written installation instructions and the applicable recommendations of the NRCA Quality Control Guidelines for Application of Polymer Modified Bitumen Roofing.
 - a. Start installing roofing membrane in the presence of the roofing system manufacturer's technical personnel.
 - b. Install the roofing membrane sheet and cap sheet starting at low point of the roofing system.
 - c. Extend the roofing membrane sheets over and terminate beyond eaves, and install the sheet as follows:
 - 1) Torch-apply the roofing membrane sheets to the substrate.
 - 2) Unroll the roofing membrane sheets, and allow them to relax for the minimum time period required by manufacturer.
 2. Asphalt Heating:
 - a. Do not raise the roofing asphalt temperature above the equiviscous temperature range more than 1 hour before the time of its application.
 - b. Do not exceed the roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating.
 - c. Do not heat roofing asphalt within 25 degrees Fahrenheit (14 degrees Celsius) of its flash point.
 - d. Discard roofing asphalt that has been maintained at a temperature exceeding the finished blowing temperature for more than 4 hours.
 - e. Heat and apply SEBS-modified roofing asphalt according to the roofing system manufacturer's written instructions.
 3. Laps:
 - a. Accurately align the roofing membrane sheets, without stretching, and maintain uniform side and end laps.
 - 1) Stagger end laps.



- 2) Completely bond and seal laps, leaving no voids.
- b. Repair tears and voids in laps and lapped seams not completely sealed.
- c. Apply roofing granules to cover the exuded bead at laps while the bead is hot.
- d. Install roofing membrane sheets so the side and end laps shed water.
4. Where the roof slope exceeds 1/2 inch per 12 inches, install the roofing membrane sheets parallel with slope.

C. Flashing and Stripping:

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through the roof; and secure the base flashing to the substrates in accordance with the roofing system manufacturer's written instructions and the following:
 - a. If required by the roofing system manufacturer, prime the substrates with asphalt primer.
 - b. Torch apply flashing sheet to the substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches above the roofing membrane, and 4 inches onto the field of the roofing membrane.
3. Mechanically fasten the top of the base flashing securely at terminations and the perimeter of roofing.
 - a. Seal the top termination of the base flashing.
4. Where metal flanges and edgings are set on the membrane roofing, install roofing membrane cap-sheet stripping according to the roofing system manufacturer's written instructions.
5. Install stripping according to the roofing system manufacturer's written instructions.

D. Roof Walkway Pads:

1. Cap Sheets:
 - a. Remove the salvage edge, cut the cap sheet into appropriate lengths, and apply these roof walkway pads in the same manner as the cap sheets.
 - b. Apply the acrylic coating in accordance with the coating manufacturer's application instructions, and clean the membrane.
 - 1) Submit the acrylic coating manufacturer's written application instructions to the Program/Project Manager for information.
2. Walkway Pads:
 - a. Adhere the walkway pads to the roofing membrane, spacing each pad not less than 1.0 inch (25mm) or more than 3.0 inches (75mm) apart to allow for drainage.

E. Interface with Other Work:

1. Roof Drains:



- a. Set a 30-inch by 30-inch piece of metal flashing on the completed roofing membrane in a bed of the roofing-manufacturer-approved asphaltic adhesive.
- b. Cover the metal flashing with roofing membrane cap-sheet stripping, and extend it a minimum of 4 inches beyond edge of the metal flashing onto the field of roofing membrane.
- c. Clamp the roofing membrane, metal flashing, and stripping into the roof-drain clamping ring.

3.04 REPAIR/RESTORATION

- A. When the remaining construction will not affect or endanger the roofing, inspect the roofing for deterioration and damage, describe its nature and extent in a written roof condition report, and submit copies to the Program/Project Manager and the Owner.
- B. Correct deficiencies in the roofing system that do not comply with specified requirements, or remove the roofing system and reinstall roofing complying with the requirements.
 1. Repair substrates, and repair or reinstall the roofing system so it is free of damage and deterioration at the time of Substantial Completion and complies with warranty requirements.

3.05 SITE QUALITY CONTROL

- A. Site Tests:
 1. Cooperate with the Testing and Inspecting Agencies engaged or required to perform services for installing roofing system.
 2. Test Cut Evaluations:
 - a. Test Procedure:
 - 1) To evaluate problems observed during quality-assurance inspections of the roofing membrane, test specimens will be removed from the installed roofing.
 - 2) The approximate quantities of components within the roofing membrane will be determined in accordance with the methods specified in ASTM D 3617.
 - 3) Test specimens will be examined for interply voids determined in accordance with the methods specified in ASTM D 3617.
 - b. Acceptance Criteria:
 - 1) Test specimens complying with the criteria established in Appendix 3 of the NRCA Quality Control Guidelines for Application of Polymer Modified Bitumen Roofing pass the test cut evaluation.
- B. Non-Conforming Work



1. Repair or remove and replace components of the atactic polypropylene-modified bituminous membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
2. Additional testing and inspection, at Contractor's expense, will be performed to determine the compliance of replaced or additional work with the specified requirements.

C. Manufacturer Services:

1. Final Roof Inspection:
 - a. Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, and to prepare and submit an Inspection Report to Program/Project Manager.
 - 1) Notify the Program/Project Manager 48 hours in advance of the date and time of this inspection.

3.06 CLEANING

- A. Clean overspray and spillage from atactic polypropylene-modified bituminous membrane roofing system on adjacent construction using cleaning agents and procedures recommended by the manufacturer of the affected construction.
- B. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protecting Components Not Permanently Exposed:
 1. Coordinate installation of the roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday, or when rain is forecast.
 - a. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
 - b. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of the roofing system.
 - c. Remove and discard temporary seals before beginning work on adjoining roofing.
- B. Protect the completed roofing system from damage and wear during the remainder of the construction period.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:



1. Submit maintenance information for the atactic polypropylene-modified bituminous membrane roofing system in Operation and Maintenance manuals to the Program/Project Manager for approval.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 07610

SHEET METAL ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for sheet metal roofing panels, thermally responsive clips, fasteners, flashing, closures, insulation and related accessories required for a complete roofing system as indicated in the Contract Documents.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07620 - Sheet Metal Flashing and Trim.
 - 5. Section 07920 – Joint Sealants.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. MD: Machine direction.
 - 3. SBS: Styrene-butylene-styrene plastic.
 - 4. XD: Cross direction.
- B. Definitions:
 - 1. NBS Unit: Short for the National Bureau of Standards (NBS) Unit of Color Difference, a unit to describe the size of the difference, ΔE , between 2 colors of tristimulus specifications based on Equation 13 in the now obsolete NBS Circular C429, Photoelectric Tristimulus Colorimetry with Three Filters.
- C. Reference Standards:



1. American Iron and Steel Institute (AISI):
 - a. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
 - b. AISI S200 - North American Standard for Cold-Formed Steel Framing – General Provisions.
 - c. AISI S201 - North American Standard for Cold-Formed Steel Framing – Product Data.
 - d. AISI S210 - North American Standard for Cold-Formed Steel Framing – Floor and Roof System Design.
 - e. AISI S211 - North American Standard for Cold-Formed Steel Framing – Wall Stud Design.
 - f. AISI S212 - North American Standard for Cold-Formed Steel Framing Header Design.
 - g. AISI S213 - North American Standard for Cold-Formed Steel Framing – Lateral Design.
2. ASTM International (ASTM):
 - a. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - b. ASTM D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - c. ASTM D 523 – Standard Test Method for Specular Gloss.
 - d. ASTM D 822 – Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - e. ASTM D 903 – Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - f. ASTM D 968 – Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
 - g. ASTM D 1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - h. ASTM D 1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - i. ASTM D 2244 – Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
 - j. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity.
 - k. ASTM D 2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - l. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.



- m. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
- n. ASTM D 4145 – Standard Test Method for Coating Flexibility of Prepainted Sheet.
- o. ASTM D 4212 – Standard Test Method for Viscosity by Dip-Type Viscosity Cups.
- p. ASTM D 4214 - Standard Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
- q. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.
- r. ASTM E 1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
- s. ASTM E 1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
- t. ASTM E 1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. FM Approvals LLC (FM):
 - a. FM Class Number 4471 – Approval Standard for Class 1 Roof Panels.
 - b. The Approval Guide, www.approvalguide.com.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 6. Structural Engineering Institute (SEI)/American Society of Civil Engineers (ASCE):
 - a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- 7. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - b. UL 580 – Standard for Tests for Uplift Resistance of Roof Assemblies.
 - c. Institute for Sustainability Infrastructure (ISI)
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 SUBMITTALS

A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Sheet metal roof panels.
 - 2) Sheet metal roof clips.
 - 3) Flashing.
 - 4) Underlayment materials.
 - 5) Fall arrest/restraint system.
 - b. Shop Drawings:
 - 1) Standing seam roof system.
 - c. Samples:
 - 1) Roof panels.
 - 2) Panel system clips.
 - 3) Fasteners.
 - 4) Closures.
 - 5) Insulation.
 - 6) Sealants.
 - d. Delegated Design Submittals:
 - 1) Professional Engineer's structural design calculations and test reports.
 - e. Qualification Statements:
 - 1) Professional Engineer's qualifications.
 - 2) Sheet metal roofing manufacturer's qualifications.
 - 3) Sheet metal roofing installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Sheet metal roof system manufacturer's published installation instructions.
 - b. Source Quality Control Submittals:
 - 1) Uniform Uplift Load Capacity Test certified laboratory test report.
 - 2) Clip Fastener Pull-Out Test certified laboratory test report.
 - 3) Uplift – Class Test certified laboratory test report.
 - 4) Concentrated Load Test certified laboratory test report.
 - 5) Air Infiltration Test certified laboratory test report.
 - 6) Water Penetration Test certified laboratory test report.
 - 7) Thermal Cycle Test certified laboratory test report.



- 8) Factory Mutual Wind Uplift Resistance Test certified laboratory test report.
- c. Site Quality Control Submittals:
 - 1) Sheet metal roofing manufacturers field service representative's written field report.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Sheet Metal Roofing Materials and Workmanship Warranty.
 - 2) Sheet Metal Roofing Weather Tightness Warranty.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Professional Engineer's Qualifications:
 - a. Engage a Professional Engineer registered in the State of Arizona, and qualified to perform the structural calculations and tests required for the sheet metal roofing.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.
 - 2. Sheet Metal Roofing Manufacturer's Qualifications:
 - a. Obtain sheet metal roofing products from a manufacturer having at least 10 years of experience manufacturing architectural and industrial roofing systems, and that has successfully completed projects similar in materials and scope to the Work of this Contract.
 - b. Submit the sheet metal roofing manufacturer's qualifications to the Program/Project Manager for approval.
 - 3. Sheet Metal Roofing Installer's Qualifications:
 - a. Only employ a sheet metal roofing installer that has been trained and certified by the manufacturer to provide a complete single source weather-tight package, and that will provide a single source of responsibility for this portion of the Work.
 - b. Employ a sheet metal roofing installer having a minimum of 5 years of experience installing structural field-formed concealed clip roofing systems, and that has successfully completed projects similar in materials and scope to the Work of this Contract.
 - c. Submit the sheet metal roofing installer's qualifications to the Program/Project Manager for approval.
- B. Sustainability Standards Certifications:
 - 1. Roof Submittal:



- a. For the roofing materials used within the sheet metal roofing system, submit Product Data, including a printed statement of the Solar Reflectance Index (SRI).
- C. Site Samples:
 - 1. Submit the following Samples to the Program/Project Manager for approval:
 - a. Roof Panels:
 - 1) 12-inch long Samples of the roof panels that are the full width of the sheet metal roof panels.
 - b. Panel System Clips:
 - 1) Provide 2 Samples of the panel system clips.
 - c. Fasteners:
 - 1) Provide 2 Samples of each type of fastener to be used, and include a statement identifying the intended use of each.
 - d. Closures:
 - 1) Provide 1 metal closure Sample and one neoprene closure Sample.
 - e. Insulation:
 - 1) Provide a 12 inch square insulation Sample having the thickness specified.
 - f. Sealants:
 - 1) Provide 1 Sample of each type of sealant, and include a statement identifying the intended use of each.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Inspect sheet metal roofing materials for broken battens, tie down damage between battens, and diesel smoke stains.
 - a. Photo document damage, note the damage on the receipt, and have the driver sign the receipt.
- B. Storage and Handling Requirements:
 - 1. Before delivering sheet metal roofing materials to the Site, secure suitable facilities for storing and protecting the sheet metal roofing materials onsite.
 - 2. When unloading and hoisting bundles of roof panels, furnish slats under the slings, limit lift points to 30 feet apart, and limit overhangs to 15 feet.
 - a. Always use slings, and not cables or chains which can damage the panels, to lift the bundles.
 - b. Use spreader bars if the distance between the outer pick points is greater than the length of the cable.



- c. Use spreader planks between the sling and the bottom and top of the bundles to prevent damaging the corners of roof panels.
3. Slope stored roof panels to promote drainage.
 - a. Avoid placing bundles so they can trap water.
4. Cover the bundles of roof panels.
5. Vent the ends of bundles.
6. Avoid storing bundles of roof panels on wet ground.
7. On roofs, tie roof panels down to protect them from wind, and brace the roof panels on steep slopes.
 - a. Place bundles on the roof where the load will be supported.
 - b. Avoid loading decking, purlins, and bar joists at mid-span.
 - c. Locate bundles over primary structural supports near column lines.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.06 WARRANTY

A. Manufacturer Warranty:

1. Sheet Metal Roofing Materials and Workmanship Warranty
 - a. Warrant the sheet metal roofing materials and workmanship against standard performance failures within the 2-year period after the Date of Substantial Completion:
 - b. Submit a written Sheet Metal Roofing Materials and Workmanship Warranty on the manufacturer's standard or customized form, without monetary limitation, in which the sheet metal roofing manufacturer agrees to repair or replace components of the roofing system, including the roofing system panels, flashings, sealants, fasteners, and accessories that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

B. Special Warranty:

1. Sheet Metal Roofing Weather Tightness Warranty:
 - a. Have the sheet metal roofing manufacturers/erectors warrant the weather tightness of the sheet metal roofing against failures within the 20-year period after the Date of Substantial Completion.
 - b. Submit a written Sheet Metal Roofing Weather Tightness Warranty, without monetary limitation, in which the sheet metal roofing manufacturers/erectors agree to repair defects in the weather



tightness of the roofing system, including replacing defective materials with weather tight materials.

PART 2 PRODUCTS

2.01 SHEET METAL ROOFING SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.

- 1) Bemo USA, Basis-of-Design: Bemo-Roof system,
<http://www.bemousa.com>.
- 2) Overly Manufacturing Company, Batten "C" Profile system,
<http://www.overlymanufacturing.com>.
- 3) Merchant and Evens, Inc., Zip-Rib® Standing Seam Panels,
<http://www.ziprib.com>.
- 4) Centria, SRS 3 Structural Standing Seam Roof System,
<http://www.centria.com>.

- 5) Approved equal.

2. Substitution Limitations:

- a. The manufacturers listed in this Section are prequalified manufacturers.
 - 1) Substitution of a manufacturer's alternate products for those specified at any time during the bidding or construction phases of this Contract is not allowed.
 - 2) Requests to use alternate systems must be submitted in writing to the Program/Project Manager at least 10 days prior to the bid date.
 - a) Performance requirements, certified statements, Samples, sample warranties and descriptive data must accompany the request for substitution.
- b. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - 1) Substitutions must fully comply with specified requirements.

B. Description:

1. Regulatory Requirements:

- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC



- International Building Code (IBC) as Amended by the City of Phoenix].
2. Sustainability Requirements:
 - 1) Provide roofing having a Solar reflective index (SRI) complying with the following requirements:
 - a) For roof slopes less than 2:12: Greater than or equal to 78.
 - b) For roof slopes greater than or equal to 2:12: 29.
- C. Performance:
1. Being listed as a prequalified manufacturer does not release the manufacturer from providing complete and acceptable performance data as specified in this Section.
 2. Sheet Metal Roofing System:
 - a. Uniform Uplift Load Capacity:
 - 1) Determine the structural-uniform uplift load capacity of the panel system in accordance with the methods specified in ASTM E 1592 as follows:
 - a) For the panel and clip/halter ultimate loads, apply a factor of safety of 1.65 on the test results with no increase for wind.
 - b) For the fasteners, apply a factor of safety of 3.0 for a single fastener in each connection, a factor of safety of 2.25 for 2 or more fasteners in each connection, and a factor of safety of 4.0 in masonry.
 - c) The design uplift capacity for gages, spans, or loading conditions other than those tested may be determined by interpolation of the test results.
 - d) For positive loading, limit deflection to L/180.
 - b. Water Penetration:
 - 1) Provide panel assemblies having “no uncontrollable leakage” for 15 minutes at a pressure of 20 pounds per square foot when tested in accordance with the method specified in ASTM E 1646.
 - c. Air Infiltration:
 - 1) Provide panel assemblies having air infiltration of no more than 0.006 cubic feet per minute per square foot of panel at a pressure of 20 pounds per square foot pressure when tested in accordance with the method specified in ASTM E 1680.
 - d. Underwriters Laboratories, Inc. (UL) Uplift – Class:
 - 1) Provide a panel system having an Underwriters Laboratories, Inc. (UL) Uplift - Class rating of 90 when tested in accordance with the methods specified in UL 580.
 3. Fall Arrest/Restraint System:
 - a. Longitudinal Direction:



- 1) Provide a fall arrest/restraint system capable of withstanding 4136 pounds (18.4kN) of force parallel to the standing seam of the roof system.
 - b. Transverse Direction:
 - 1) Provide a fall arrest/restraint system capable of withstanding 3327 pounds (14.8kN) of force 90 degrees to the standing seam of the roof system.
- D. Design Criteria:
1. Sheet Metal Roofing System:
 - a. Design the standing seam roof system to safely resist the positive and negative loads required for the location and type of structure indicated in the Contract Drawings.
 - b. Provide roof panels that are fabricated full length with no end lap conditions.
 - c. For fastening the roofing panels to the structure, provide halters/clips designed to be concealed and allow panel movement up to and including 3-3/4 inches without impeding the performance of the panel.
 2. Fall Arrest/Restraint System:
 - a. Design the fall arrest/restraint system so it does not need to penetrate the standing seam metal roofing system.
 - 1) Design the fall arrest/restraint system so all attachments to the roof will be made to the standing seam, and will not hinder the thermal movement of the roof panels.
 3. Product Data:
 - a. Obtain the standing seam roof system manufacturer's complete catalog cuts for the sheet metal roofing proposed for the Work of this Section.
 - b. Submit the standing seam roof system manufacturer's Product Data to the Program/Project Manager for approval.
 4. Shop Drawings:
 - a. Prepare complete Shop Drawings for the standing seam roof system, including clearly indicated details, roof plans, wall elevations, and field installation notes.
 - 1) Have the standing seam roof system manufacturer approve the Shop Drawings before submitting them to the Program/Project Manager for approval
 - b. Submit the standing seam roof system Shop Drawings to the Program/Project Manager for approval.
 - 1) The Program/Project Manager must approve the Shop Drawings prior to the manufacturer starting to fabricate the sheet metal roofing.



5. Calculations:

- a. Have the Professional Engineer prepare structural design calculations and test reports for the carrying capacities and thermal movement allowances of the sheet metal roofing, and sign and seal these calculations to certify and verify the loads.
- b. Submit the Professional Engineer's structural design calculations and test reports to the Program/Project Manager for approval.

E. Materials:

1. Sheet Metal Roof Panels:

- a. Provide roof panels fabricated from aluminum Alloy 3105 or aluminum Alloy 3004-H-34, and that have a smooth finish.
- b. Provide roof panels that are at least 0.040 inches thick, no more than 16 inches wide, and that have a vertical standing leg at least 2-1/2 inches high.
- c. During the manufacturing process of the panel system, provide a continuous weather seal on the roof panels.

2. Sheet Metal Roof Clips:

- a. To fasten the standing seam roofing to the structure, provide specially designed and tested concealed sheet metal roof clips manufactured exclusively for the standing seam roofing system.
- b. Provide two-piece, thermally responsive, sliding sheet metal roof clips designed to allow the roofing materials free movement parallel to the standing leg of the panel without binding.
- c. Provide sheet metal roof clips capable of passing the loaded 100,000 cycle test with zero wear between the clip and the panel.

3. Flashing:

- a. Provide trim materials having the same gage and finish specified for the panel system.

4. Underlayment Materials:

- a. Provide cold applied, self-adhering, high-temperature sheet membrane underlayment that is at least 40 mils thick, and is fabricated from a slip resistant polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive having a split release paper backing.
 - 1) To reduce solar heat gain, provide membrane underlayment having a white surface; black or gray is unacceptable.
- b. If required, provide a primer compatible with the underlayment materials and recommended by the manufacturer.
- c. Minimum Membrane Performance Characteristics:
 - 1) Thermal Stability:



- a) Provide membrane underlayment that is stable after testing at 240 degrees Fahrenheit (116 degrees Celsius) in accordance with the Thermal Stability test method specified in ASTM D 1970.
- 2) Low Temperature Flexibility:
 - a) Provide membrane underlayment that passes after testing at minus 20 degrees Fahrenheit (29 degrees Celsius) in accordance with the Low Temperature Flexibility test method specified in ASTM D 1970.
- 3) Tensile Strength:
 - a) Provide membrane underlayment having a tensile strength in the machine direction (MD) of 11,200kN/m² (1624 pounds per square foot), and in the cross direction (XD) of 13,100kN/m² (1900 pounds per square foot), when tested using Die C in accordance with the method specified in ASTM D 412.
- 4) Ultimate Elongation:
 - a) Provide membrane underlayment having an ultimate elongation in the machine direction (MD) of 88 percent, and in the cross direction (XD) of 55 percent, when tested using Die C in accordance with the method specified in ASTM D 412.
- 5) Recommended Exposure:
 - a) Provide membrane underlayment having a recommended exposure limit of 90 days.
- 6) Adhesion:
 - a) Provide membrane underlayment having an adhesion at 50 degrees Fahrenheit of 2000 kilograms per millimeter (11.4 pounds per inch) of width when tested in accordance with the method specified in ASTM D 903.
- 7) Permeance:
 - a) Provide membrane underlayment having a maximum permeance of 0.90 nanograms per square meter per second per Pascal (0.016 perm) when tested in accordance with the method specified in ASTM E 96/E 96M.

F. Fabrication:

- 1. Shop Fabrication:
 - a. Manufacture each panel, including curved panels, in continuous lengths having no end laps and without distorting the standing seam leg of the roof panel.
 - 1) Fabricator-owned, installer-owned, toll-formed, private label formed, and third party licensed roll formed products are strictly prohibited; and are unacceptable for the Work of this Contract.



- b. Equipment Requirements:
 - 1) The manufacturing equipment must be owned and operated by the manufacturer.
 - 2) Mobile Factory Roll-Forming Equipment:
 - a) Furnish a mobile UL-certified factory roll former capable of forming sheet metal roofing profiles as required for the Work of this Contract, and having the following minimum features:
 - (1) Post roll-form profiled shear.
 - (a) No pre-sheared products are acceptable.
 - (2) At least 12 roll forming stages of hardened tooling to ensure proper quality control of the profile.
 - (3) In-line seam sealant injection system.
 - (4) Coil capacity of at least 5000 pounds to minimize coil changes.
 - (5) The ability to fabricate continuous-length roll-formed panels.
 - (6) In-Line metal cooling system to minimize heat induced stress (oil canning) in the finished roll formed profiles.
 - (7) A mill having hardened tolling, a post shear block, a decoiler, and a power source weighing at least 30,000 pounds.

G. Finishes:

- 1. Primer Materials:
 - a. Provide a primer that is compatible with both the substrate and the topcoat.
- 2. Finish Materials:
 - a. Topcoat:
 - 1) Provide a coating that includes 70 percent polyvinylidene.
 - b. Provide a coating system tested for and exhibiting the minimum test criteria for the following characteristics:
 - 1) Specular Gloss:
 - a) Provide a coating system having a standard gloss of 20-30 when measured at 60 degrees Fahrenheit in accordance with the method specified in ASTM D 523.
 - 2) Pencil Hardness:
 - a) Provide a coating system having a pencil hardness of HB-H when measured in accordance with the method specified in ASTM D 3363.
 - 3) Flexibility:
 - a) Provide a coating system having a T-bend flexibility exhibiting no cracking or tape removal of film at 1-T on painted



aluminum and at 2-T on paint steel when measured in accordance with the method specified in ASTM D 4145.

- 4) Adhesion/Reverse Impact:
 - a) Provide a coating system having an adhesion/reverse impact having no cracking or loss of adhesion when coatings 1.5 times the metal thickness are measured in accordance with the method specified in ASTM D 2794, and having no loss of adhesion when measured in accordance with the method specified in ASTM D 3359.
- 5) Abrasion/Falling Sand:
 - a) Provide a coating system requiring 50 liters of falling sand to expose a 5/32 inch (4mm) diameter of substrate when measured in accordance with Method A specified in ASTM D 968.
- 6) Acid Pollutants:
 - a) Provide a coating system experiencing no effect when exposed to 10 percent muriatic acid for 15 minutes, and no effect when exposed to 20 percent sulfuric acid for 15 minutes when measured in accordance with the method specified in ASTM D 1308.
- 7) Salt Spray Resistance:
 - a) Provide a coating system passing the salt spray resistance test when coated aluminum is exposed to a 5 percent salt spray at 95 degrees Fahrenheit for 3000 hours, and when coated steel is exposed to a 5 percent salt spray at 95 degrees Fahrenheit for 1000 hours, in accordance with the method specified in ASTM B 117.
- 8) Humidity Resistance:
 - a) Provide a coating system passing a humidity resistance test when coated aluminum is exposed to 100 percent relative humidity at 95 degrees Fahrenheit for 3000 hours, and when coated steel is exposed to 100 percent relative humidity at 95 degrees Fahrenheit for 1000 hours, in accordance with the method specified in ASTM D 2247.
- 9) Weathering Tests:
 - a) Provide a coating system having less than 5 NBS units of change in color when measured in a South Florida Exposure in accordance with the method specified in ASTM D 2244.
 - b) Provide a coating system that passes the color retention test when measured in accordance with the method specified in ASTM D 822 after 5000 hours of exposure.



- c) Provide a coating system having a Chalk Rating of at least 8.0 when measured in accordance with the method specified in ASTM D 4214.
- 3. Shop Finishing Methods:
 - a. Exterior Surface of Panels:
 - 1) Apply a finish consisting of a nominal 0.2 mil primer and nominal 0.8 mil topcoat.
 - 2) Apply a nonmetallic, non-exotic color selected by the Program/Project Manager from the manufacturer's standard range.

2.02 ACCESSORIES

- A. Fall Arrest/Restraint System:
 - 1. Provide a fall arrest/restraint system manufactured by the standing seam metal roof system manufacture, and having the following components:
 - a. Brackets:
 - 1) For end and corner attachment, provide a universal standing seam roof anchor having a bracket framework fabricated from Type 316 stainless steel.
 - b. Intermediate Anchors:
 - 1) For attachment between brackets, provide intermediate anchors having a bracket framework fabricated from Type 316 stainless steel.
 - c. End Anchorage Connectors:
 - 1) Provide end anchorage connectors fabricated from Type 316 stainless steel.
 - d. Swages:
 - 1) Provide swages fabricated from Type 316 stainless steel.
 - e. Tensioners:
 - 1) Provide tensioners fabricated from Type 316 stainless steel.
 - f. Cables:
 - 1) Provide cables having polyester covers and core yarn, red neoprene membranes made from a proprietary polychloroprene formula, and compounds made from proprietary latex formulas.
 - g. Fixed Corner Units:
 - 1) Provide fixed corner units fabricated from Type 316 stainless steel.
 - 2. Manufacturers:
 - a. Bemo USA, Basis-of-Design: Xtreme Uniline Safety Systems, <http://www.bemousa.com>.
 - b. Approved equal.



2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. At the time the sheet metal roofing components are being manufactured, have an independent Testing and Inspection Agency or an independent Professional Engineer test the sheet metal roofing components in accordance with the following methods to verify that the proposed roofing will meet the performance requirements specified herein:
2. Uniform Uplift Load Capacity Test:
 - a. Test Procedure:
 - 1) Determine the structural-uniform uplift load capacity of the panels and clip/halters for the sheet metal roofing panel system in accordance with the methods specified in ASTM E 1592 applying a factor of safety of 1.65 onto the test results with no increase for wind.
 - b. Acceptance Criteria:
 - 1) Sheet metal roofing panel system panels and clip/halters not failing when the calculated deflection allowing for the safety factor is equal to or less than $L/180$ pass the Uniform Uplift Load Capacity Test.
3. Clip Fastener Pull-Out Test:
 - a. Test Procedure:
 - 1) Determine the structural-uniform uplift load capacity of the clip fasteners for the sheet metal roofing panel system in accordance with the methods specified in ASTM E 1592 applying a factor of safety of 3.0 for a single fastener in each connection, a factor of safety of 2.25 for 2 or more fasteners in each connection, and a factor of safety of 4.0 for fasteners in masonry.
 - b. Acceptance Criteria:
 - 1) Sheet metal roofing panel system clip fasteners not failing when the calculated deflection allowing for the safety factors is equal to or less than $L/180$ pass the Uniform Uplift Load Capacity Test.
4. Uplift – Class Test:
 - a. Test Procedure:
 - 1) Obtain the Uplift – Class test data for the sheet metal roofing performed in accordance with the method specified in UL 580 and the report number.
 - b. Acceptance Criteria:
 - 1) Roof systems having an Underwriters Laboratories, Inc. (UL) Uplift - Class rating of 90 pass the Uplift – Class Test
5. Concentrated Load Test:
 - a. Test Procedure:



- 1) Apply concentrated loads equal to the loads specified for the fall arrest/restraint system to the roof system.
- b. Acceptance Criteria:
 - 1) Sheet metal roofing panel assemblies demonstrating they can withstand the concentrated loads imposed by the fall arrest/restraint system pass the Concentrated Load Test.
6. Air Infiltration Test:
 - a. Test Procedure:
 - 1) Determine the sheet metal roofing's air infiltration rate in accordance with the test method specified in ASTM E 1680.
 - b. Acceptance Criteria:
 - 1) Panel assemblies having air infiltration of no more than 0.006 cubic feet per minute per square foot of panel at a pressure of 20 pounds per square foot pressure pass the Air Infiltration Test.
7. Water Penetration Test:
 - a. Test Procedure:
 - 1) Determine the sheet metal roofing's water penetration rate in accordance with the test method specified in ASTM E 1646.
 - b. Acceptance Criteria:
 - 1) Sheet metal roofing panel assemblies having "no uncontrollable leakage" pass the Water Penetration Test.
8. Thermal Cycle Test:
 - a. Test Procedure:
 - 1) Perform the Thermal Cycle Test on the sheet metal roof clips for 100,000 cycles.
 - b. Acceptance Criteria:
 - 1) Sheet metal roof clips capable of passing the loaded 100,000 cycle test with zero wear between the clip and the panel pass the Thermal Cycle Test.
9. Factory Mutual Wind Uplift Resistance Test:
 - a. Test Procedure:
 - 1) Perform the Factory Mutual Wind Uplift Resistance in accordance with the procedure specified in FM Class Number 4471.
 - b. Acceptance Criteria:
 - 1) Sheet metal roofing panel assemblies having at least a Class 1-120 Windstorm Classification pass the Factory Mutual Windstorm Classification Test.
10. Submit laboratory test reports, certified by the independent Testing and Inspection Agency or an independent Professional Engineer, for the tests performed; and that show the proposed sheet metal roofing system has been properly factory-tested, and conforms to the applicable provisions specified herein; to the Program/Project Manager for information.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. To verify that the structure is ready for installation of the roofing, examine the building substrates and Site conditions with the manufacturer/installer present for compliance with the requirements of the Sections in which the substrates and related work are specified, and for other Site conditions affecting performance of the sheet metal roofing.
 - a. Verify that the panel supports are within the manufacturer's tolerances.
- B. Evaluation and Assessment:
 - 1. Do not proceed to install the sheet metal roofing until all structural supports and/or substrates are satisfactorily installed in accordance with the approved Shop Drawings, Specifications, and applicable industry standards.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the sheet metal roofing.

3.03 INSTALLATION

- A. Install the sheet metal roof system in accordance with the sheet metal roof system manufacturer's installation instructions.
 - 1. Submit the sheet metal roof system manufacturer's published installation instructions to the Program/Project Manager for information.
- B. Curving Mill:
 - 1. Onsite curving is mandatory.
 - 2. Furnish a curving mill capable of inducing a smooth curve into the panel profiles to the radius required for the Work of this Contract.
 - a. Dimple or crimp curving to induce the panel radius is unacceptable.
- C. Install the metal roof panels with the orientation, of the sizes, and at the locations indicated in the Contract Drawings.
 - 1. For whatever length required, install panels having one continuous, unbroken length from the ridge to the eave unless otherwise indicated on the approved Shop Drawings.



- D. Anchor the panels and other components securely in place, anchoring the roof panels to the supports using the manufacturer's recommended clips, screws, fasteners, sealants, and adhesives indicated on the approved Shop Drawings.
 - 1. Provide only attachments that allow for thermal expansion and contraction of the roofing materials.
- E. Mechanically seam the panels after installation in the field.
- F. Joint Sealers:
 - 1. Provide joint sealers where indicated in the approved Shop Drawings and where required to produce weatherproof performance of the sheet metal roof assemblies.
 - 2. Prepare the joints, and apply the sealants, as specified in Section 07920, Joint Sealants.
- G. Flashing and Trim:
 - 1. Provide related flashing and trim in accordance with the requirements specified in Section 07620, Sheet Metal Flashing and Trim.
- H. Provide weatherproof escutcheons for pipe and conduit that penetrates the roof.
- I. Special Techniques:
 - 1. Dissimilar Materials:
 - a. Where elements of the metal panel system come into contact with dissimilar materials, treat the faces and edges in contact with dissimilar materials as recommended by the sheet metal roofing manufacturer.

3.04 REPAIR/RESTORATION

- A. Replace any materials or components that are damaged beyond repair prior to completion, with undamaged materials.

3.05 SITE QUALITY CONTROL

- A. Non-Conforming Work
 - 1. Correct deficiencies indicated in the sheet metal roofing manufacturer's service representative's field report.
- B. Manufacturer Services:
 - 1. Manufacturers Field Service:



- a. Engage a service representative of the sheet metal roofing manufacturer to inspect the completed installation, and submit a written field report to the Program/Project Manager.

3.06 CLEANING

- A. Wipe down each area as it is completed.
- B. Remove temporary protective films when directed by the Program/Project Manager.
- C. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.C.8, 1.03.B.1, 1.04.B.1, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System



SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for sheet metal flashing and trim, including the following types:
 - a. Formed roof drainage system.
 - b. Formed low-slope roof flashing and trim.
 - c. Formed wall flashing and trim.
 - d. Formed equipment support flashing.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01454 - Mock-Up Requirements.
 - 5. Section 07920 - Joint Sealants.
 - 6. Section 09961 – Fluoropolymer Coatings

1.02 REFERENCES

- A. Definitions:
 - 1. Counterflashing: Typically, a strip of sheet metal or other material built into masonry, and turned down to prevent water from entering joints and exposed upturned edges of the base flashing on a roof.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. Reglet: A groove for guiding or holding a panel, window sash, or similar item; or a narrow, flat molding.
 - 4.
- B. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturers Association (AAMA):



- a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
- b. AAMA 2604 – Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
3. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM A 755/A 755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - c. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - d. ASTM B 32 - Standard Specification for Solder Metal.
 - e. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - f. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
 - g. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.
 - h. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - i. ASTM D 523 - Standard Test Method for Specular Gloss.
 - j. ASTM D 4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
 - k. ASTM D 4586 –. Standard Specification for Asphalt Roofing Cement, Asbestos-Free.
4. FM Global (FMG), <http://www.fmglobal.com>.
 - a. FMG Property Loss Prevention Data Sheet 1-49 – Perimeter Flashing.
5. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
6. The Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. SMACNA Architectural Sheet Metal Manual.
7. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-Paint 12 – Cold-Applied Asphalt Mastic (Extra Thick Film).
8. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the Work of this Section with interfacing and adjoining Work to insure proper sequencing of each installation.
 - a. Coordinate the installation of the sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.
 - b. Coordinate the installation of equipment support flashing with roofing and equipment installation.
 - c. Coordinate the installation of roof-penetration flashing with the installation of roofing and the items penetrating the roof.
 - d. Coordinate the installation of wall flashing with the installation of wall-opening components such as windows, doors, and louvers.

B. Pre-Installation Meetings:

1. Convene a pre-installation meeting one week prior to commencing the Work of this Section in accordance with the requirements of Section 01316, Project Meetings.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Sheet Metal Flashing and Trim Materials.
 - 2) Concealed Through-Wall Sheet Metal Flashing.
 - 3) Reglets.
 - 4) Burning Rod for Lead.
 - 5) Solder.
 - 6) Fasteners.
 - 7) Bituminous Mastic.
 - 8) Mastic Sealant.
 - 9) Elastomeric Sealant.
 - 10) Epoxy Seam Sealer.
 - 11) Adhesives.
 - 12) Sheet metal clips, straps, anchoring devices, and similar accessory units.
 - b. Shop Drawings:
 - 1) Sheet Metal Flashing and Trim Materials.
 - 2) Concealed Through-Wall Sheet Metal Flashing.
 - 3) Reglets.
 - c. Samples:
 - 1) Samples for illustrating materials.



- 2) Samples for initial color selection.
 - 3) Samples for finish verification of sheet metal flashing.
 - 4) Samples for finish verification of trim.
 - 5) Samples for finish verification of accessories.
 - d. Qualification Statements:
 - 1) Fabricator qualifications.
 - 2) Installer qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Installation instructions, and general recommendations for sheet metal flashing and trim materials.
 - 2) Installation instructions, and general recommendations for concealed through-wall sheet metal flashing.
 - 3) Installation instructions, and general recommendations for reglets.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Material
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Fabricator Qualifications:
 - a. Employ a fabricator specializing in sheet metal work and having at least 2 years of documented experience in production of sheet metal flashing and trim of the type required by this Section.
 - b. Submit the fabricator's qualifications to the Program/Project Manager for approval.
 - 2. Installer Qualifications:
 - a. Employ an installer specializing in sheet metal work and having at least 2 years of documented experience installing sheet metal flashing and trim of the type required by this Section.
 - b. Submit the installer's qualifications to the Program/Project Manager for approval.
- B. Site Samples:
 - 1. Samples for Illustrating Materials:



- a. Submit two 9-inch by 9-inch Samples of flashing illustrating the material of a typical standing seam, bayonet seam, external corner, internal corner, valley condition, ridge condition, and junction to a vertical dissimilar surface to the Program/Project Manager for approval.
 2. Samples for Initial Color Selection:
 - a. For each type of sheet metal flashing and trim indicated to have factory-applied color finishes, submit two 3-inch by 3-inch flashing color Samples illustrating each metal finish color to the Program/Project Manager for approval.
 - 1) Include similar Samples of trim and accessories involving color selection.
 3. Samples for Finish Verification:
 - a. For each type of exposed finish required, submit finish Samples of the following sizes for verification to the Program/Project Manager for approval:
 - 1) Sheet Metal Flashing:
 - a) Submit 12-inch long sheet metal flashing Samples that include fasteners, cleats, clips, closures, and other attachments.
 - 2) Trim:
 - a) Submit 12-inch long trim Samples that include fasteners and other exposed accessories.
 - 3) Accessories:
 - a) Submit full-size Samples.
- C. Mock-Ups:
 1. After the Samples have been approved, build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements, to demonstrate aesthetic effects and set quality standards for fabrication and installation..
 - a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. Build mockup of typical roof copings, counterflashings, and roof drainage components including supporting construction cleats, seams, attachments, underlayment, and accessories, and using the methods to be used to install production Work.
 - 1) Construct coping and counterflashing sections not less than 96 inches long.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in the mockups unless such deviations are specifically approved by Program/Project Manager in writing.
 3. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.
 - a. Approval of mockups is for other material and construction qualities specifically approved by Program/Project Manager in writing.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
 - a. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 2. Deliver sheet metal flashing materials and fabrications undamaged.
- B. Storage and Handling Requirements:
 - 1. Unload and store install sheet metal flashing materials and fabrications in a manner that prevents bending, warping, twisting, and surface damage.
 - a. Stack the material in a manner that prevents twisting, bending, and abrasion of the material; and so that ventilation is provided around the material.
 - 1) Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering.
 - 2. Prevent contact with materials which may cause discoloration or staining.
 - a. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - b. Slope metal sheets to ensure drainage.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. When the ambient temperature at the time elastomeric sealant is installed is moderate, between 40 degrees Fahrenheit and 70 degrees Fahrenheit, set the joint members to allow 50 percent movement either way.
 - a. Adjust the setting proportionately for installation at higher ambient temperatures.
 - 2. Do not install sealant-type joints at temperatures below 40 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 SHEET METAL FLASHING AND TRIM COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
- 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 2. Sustainability Requirements:
 - a. Recycled Content
 - 1) Provide Sheet Metal Flashing and Trim whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.
- C. Performance:
- 1. Provide sheet metal flashing and trim that fit the substrates, and that result in waterproof and weather-resistant performance once installed.
 - a. Ensure the best possible weather resistance, durability of the Work, and the protection of materials and finishes.
 - 2. Provide sheet metal flashing and trim capable of withstanding wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
 - a. Structural Requirements:
 - 1) Provide copings capable of resisting the following forces in accordance with the requirements for Class 1-75 and 1-90 (velocity pressures of 31 pounds-force per square foot to 45 pounds-force per square foot) specified in FMG Property Loss Prevention Data Sheet 1-49:
 - a) Perimeter Uplift Force: 90 pounds-force per square foot.
 - b) Corner Uplift Force: 120 pounds-force per square foot.
 - c) Outward Force: 45 pounds-force per square foot.
 - b. Thermal Movements:
 - 1) Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects:
 - a) Temperature Change (Range): 120 degrees Fahrenheit for ambient temperatures, and 180 degrees Fahrenheit for material surface temperatures.



- 2) Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
- 3) Base the engineering calculation on the surface temperatures of the materials due to both solar heat gain and nighttime-sky heat loss.
- c. Water Infiltration:
 - 1) Provide sheet metal flashing and trim that do not allow water infiltration to the building interior.
- 3. Appearance of Finished Work:
 - a. Variations in the appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples.
 - b. Noticeable variations in the same piece are unacceptable.
 - c. Variations in appearance of other components are acceptable if they are within the range of approved Samples, and are assembled or installed to minimize contrast.
- D. Design Criteria:
 - 1. Sheet Metal Flashing and Trim Standard:
 - a. Provide sheet metal flashing and trim complying with the recommendations that apply to the design, dimensions, metal, and other characteristics of the item indicated the SMACNA Architectural Sheet Metal Manual.
 - 1) Unless more stringent requirements are indicated in the Contract Documents, provide sheet metal flashing and trim conforming to the dimensions and profiles shown in the SMACNA Architectural Sheet Metal Manual.
 - 2. Provide the materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete sheet metal flashing and trim installation.
 - 3. Provide sheet metal items fabricated from sheets of the thickness or weight needed to comply with performance requirements, but not less than the following requirements for each application and/or metal:
 - a. Roof-Drain Flashing:
 - 1) Provide roof-drain flashing fabricated from lead-coated copper weighing 12 ounces per square foot.
 - b. Scuppers:
 - 1) Provide scuppers fabricated from 0.0276-inch thick zinc coated steel.
 - c. Copings:
 - 1) Provide copings fabricated from aluminum-zinc alloy-coated steel having a fluoropolymer finish complying with the requirements specified in Section 09961, Fluoropolymer Coatings.
 - d. Base Flashing:
 - 1) Provide base flashing fabricated from lead-coated copper weighing 20 ounces per square foot.



- e. Counterflashing:
 - 1) Provide counterflashing fabricated from lead-coated copper weighing 16 ounces per square foot.
- f. Equipment Support Flashing:
 - 1) Provide equipment support flashing fabricated from lead-coated copper weighing 16 ounces per square foot.
- g. Roof-Penetration Flashing:
 - 1) Provide roof-penetration flashing fabricated from lead-coated copper weighing 16 ounces per square foot.
- 4. Expansion Provisions:
 - a. Space movement joints a maximum of 10 feet apart, with no joints allowed within 24 inches of a corner or intersection.
 - b. Where lapped or bayonet-type expansion provisions cannot be used, or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges not less than 1 inch deep; and fill the expansion joints with mastic sealant, concealed within the joints.
- 5. Conceal fasteners and expansion provisions where possible.
 - a. Exposed fasteners are not allowed on sheet metal faces exposed to public view.
- 6. Incompatible Metal or Corrosive Substrates:
 - a. Separate metal from incompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by flashing or trim manufacturer.
- 7. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of product proposed for the Work of this Section.
 - 1) Obtain the manufacturer's material descriptions, finish data, construction details, installation instructions, dimensions of individual components and profiles, and the general recommendations for each specified flashing material and fabricated product.
 - b. Submit the sheet metal flashing and trim Product Data to the Program/Project Manager for approval.
- 8. Shop Drawings:
 - a. Prepare Shop Drawings of each item specified showing layouts, profiles, methods of joining, and anchorage details.
 - 1) Show layouts of sheet metal flashing and trim, including plans and elevations.
 - a) Distinguish between shop- and field-assembled work.
 - 2) Identify the materials, thicknesses, weights, and finishes for each item and its location in Work.
 - 3) Include details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.



- 4) Include details for fastening, joining, supporting, and anchoring the sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
- 5) Include details of expansion-joint covers, including showing the direction of expansion and contraction.
- b. Submit the Shop Drawings to the Program/Project Manager for approval.

E. Materials:

1. Sheet Metal Flashing and Trim Materials:

- a. Zinc Coated Steel Sheet:
 - 1) Provide Designation CS steel having a 0.25 percent copper composition as specified in ASTM A 653/A 653M, and manufactured to the tolerances specified in ASTM A 924/A 924M.
 - 2) Provide steel having hot-dip galvanized Coating Designation G90 as specified in ASTM A 653/A 653M.
 - 3) Where painting is indicated, provide mill phosphatized steel.
 - 4) Thickness: 0.0239-inch thick (24 gage), except as noted otherwise.
- b. Lead Sheet:
 - 1) Provide Type L51121 copper-bearing lead sheet as specified in ASTM B 749, and having a minimum thickness of 0.0625 inch, except for applications where burning (welding) is involved provide a minimum thickness of 0.0937 inch.
- c. Aluminum Sheet:
 - 1) Provide aluminum sheets complying with the requirements for Alloy 3003, 3004, 3105, or 5005 specified in ASTM B 209; having a temper suitable for the forming and structural performance required, but not less than H14; and having a thickness of 0.032 inch.
- d. Pre-Finished Aluminum Sheet:
 - 1) Provide pre-finished aluminum sheets complying with the requirements of ASTM B 209; and consisting of 0.032 inch thick plain finish aluminum shop pre coated with a fluoropolymer coating of the color as selected by the Program/Project Manager.
- e. Stainless-Steel Sheet:
 - 1) Provide stainless-steel sheet complying with the requirements for Type 304 stainless-steel specified in ASTM A 240/A 240M, and having a Number 2D (dull, cold rolled) finish.
- f. Copper:
 - 1) For fully concealed flashing, provide 10 ounce copper.
 - 2) For flashing not fully concealed, provide 16 ounce copper.
- g. Pre-Painted, Metallic-Coated Steel Sheet:
 - 1) Provide steel sheet metallically coated using the hot-dip process and, and pre-painted using the coil-coating process in accordance with the requirements specified in ASTM A 755/A 755M.



- 2) Zinc-Coated (Galvanized) Steel Sheet:
 - a) Provide zinc-coated (galvanized) steel sheet complying with the requirements for structural quality steel having a G90 coating designation specified in ASTM A 653/A 653M.
 - 3) Exposed Finishes:
 - a) High-Performance Organic Finish:
 - (1) Prepare, pretreat, and apply a coil coating to exposed metal surfaces in accordance with the coating and resin manufacturers' written instructions.
 - b) Fluoropolymer 3-Coat System:
 - (1) Provide the manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil; complying with physical properties and coating performance requirements of AAMA 2605, except as modified as follows:
 - (a) Humidity Resistance: 2000 hours.
 - (b) Salt-Spray Resistance: 2000 hours.
 - 4) Color:
 - a) Provide a color matching samples selected by the Program/Project Manager from the manufacturer's full range.
2. Underlayment Materials
- a. Polyethylene Sheet:
 - 1) Provide 6-mil thick polyethylene sheet complying with the requirements specified in ASTM D 4397.
 - b. Felts:
 - 1) Provide nonperforated felts complying with the requirements for Type II (No. 30) asphalt-saturated organic felt specified in ASTM D 226.
 - 2) Slip Sheets:
 - a) Provide rosin-sized paper slip sheets having a minimum 3 pounds per 100 square feet weight for use over felt underlayment.

F. Assemblies:

1. Concealed Through-Wall Sheet Metal Flashing:
 - a. Fabricate concealed through-wall metal flashings embedded in concrete or masonry from copper with ribs formed in a dovetail pattern at 3 inch intervals along the length of the flashing to provide a 3-way integral mortar bond and weep-hole drainage.
 - b. Manufacturers:
 - 1) Cheney Flashing Company, Inc., Cheney Flashing (Dovetail), www.cheneyflashing.com.



- 2) Keystone Flashing Company, Keystone Three-Way Interlocking Thruwall Flashing, www.keystoneflashing.com.
 - 3) Approved equal.
2. Reglets:
 - a. Provide reglet units of the type, material, and profile indicated on the Contract Drawings, formed to securely interlock the separate reglet and counterflashing pieces, and compatible with the flashing indicated.
 - b. Masonry Type:
 - 1) Provide masonry type reglets having offset top flanges for embedment in masonry mortar joints or concrete panels.
 - c. Flexible Flashing Retainer:
 - 1) Provide resilient plastic or rubber accessories designed to secure flexible flashing in reglets where the clearance does not permit using standard metal counterflashing, or where the Contract Drawings show reglets without metal counterflashing.
 - d. Counterflashing Wind-Restraint Clips:
 - 1) To prevent wind uplift of the lower edge of counterflashing, provide restraining clips to be installed before installing the counterflashing.
 - e. Manufacturers:
 - 1) Fry Reglet Corporation, www.fryreglet.com.
 - 2) W.P. Hickman Company, www.wphickman.com.
 - 3) Keystone Flashing Company, www.keystoneflashing.com.
 - 4) Approved equal.
3. Low-Slope Roof Sheet Metal Fabrications:
 - a. Copings:
 - 1) Provide copings fabricated of either 0.050-inch thick aluminum or 0.0396 inch thick pre-painted, metallic-coated steel; and in sections at least 96 inches long, but not exceeding 10-foot long.
 - 2) Fabricate joint plates the same thickness as the copings.
 - 3) Provide copings having continuous cleats to support the edge of the external leg, and drill elongated holes for fasteners on the interior leg.
 - 4) Miter the corners, and seal and solder or weld the copings so they are watertight.
 - b. Counterflashing:
 - 1) Provide counterflashing fabricated from either 0.0396-inch thick galvanized steel or 0.0396-inch thick prepainted, metallic-coated steel.
 - c. Roof Coping and Trim Coating System:
 - 1) Color:
 - a) Provide a prefinished coating color to match the prefinished roof system unless otherwise selected by the Program/Project Manager.



4. Wall Sheet Metal Fabrications:
 - a. Openings Flashing in Frame Construction:
 - 1) Provide head, sill, jamb, and similar flashings fabricated from 0.0396 inch thick galvanized steel and so they extend 4 inches beyond the wall openings.
 - 2) Form head and sill flashing with 2-inch high end dams.
5. Miscellaneous Sheet Metal Fabrications:
 - a. Equipment Support Flashing:
 - 1) Fabricate equipment support flashing from 0.0396 inch thick pre-painted, metallic-coated steel.

2.02 SHOP FABRICATION:

- A. Custom fabricate sheet metal flashing and trim to comply with recommendations in the SMACNA Architectural Sheet Metal Manual that apply to design, dimensions, metal, and other characteristics of the item indicated.
 1. Shop fabricate items where practicable.
 2. Fabricate sheet metal flashing and trim according to the details shown on the Contract Drawings, to fit the substrates true to the line and levels indicated.
 3. Form exposed sheet metal work without excessive oil canning, buckling, and tool marks; and with exposed edges folded back to form hems.
- B. Thicknesses:
 1. Fabricate the sheet metal flashing and trim to have the thickness or weight needed to comply with the performance requirements, but not less than that specified for each application and metal.
 2. Fabricate the sheet metal flashing and trim to have the thickness recommended for application in the SMACNA Architectural Sheet Metal Manual and FMG Property Loss Prevention Data Sheet 1-49, but not less than thickness of metal being secured.
- C. Seams:
 1. Fabricate nonmoving seams in aluminum and sheet metal with flat-lock seams.
 - a. In aluminum, form the seams, seal them with epoxy seam sealer, then rivet the joints for additional strength.
 - b. In sheet metal, tin the edges to be seamed, form the seams, and then solder the seams.
 2. Joint Type:
 - a. Provide butt joint assemblies having a 12-inch- wide concealed backup plate, filled with elastomeric sealant concealed within the joints.
 3. Sealed Joints:



- a. Form non-expansion, but movable, joints in the metal to accommodate elastomeric sealant as indicated in the SMACNA Architectural Sheet Metal Manual.

D. Cleats and Attachment Devices:

1. Fabricate cleats and attachment devices from same material as sheet metal component being anchored, or from compatible, noncorrosive metal as recommended by the sheet metal manufacturer.
2. Provide cleats and attachment devices sized as recommended by the SMACNA Architectural Sheet Metal Manual or the sheet metal manufacturer for the application, but never less than the thickness of the metal being secured.
3. Unless otherwise indicated in the Contract Documents, conceal fasteners and expansion provisions wherever possible on exposed-to-view sheet metal flashing and trim.

2.03 FINISH MATERIALS:

- A. For recommendations for applying and designating finishes, comply with the recommendations specified in NAAMM AMP 500.

B. Aluminum Finishes:

1. Finish designations prefixed by AA refer to finishes defined by the system for designating aluminum finishes established by the Aluminum Association and specified in AA DAF-45.
2. Anodized Finishes:
 - a. Clear Anodized Finish:
 - 1) Provide an AAMA 611 AA-M12C22A41 Class I clear anodic coating not less than 0.7 mils thick.
 - b. Color Anodized Finish:
 - 1) Provide an AAMA 611 AA-M12C22A42/44 Class I integrally or electrolytically [champagne][light bronze][medium bronze][black][dark bronze] colored anodic coating not less than 0.7 mils thick.
3. High-Performance Organic Finish:
 - a. Provide an AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating) finish.
 - 1) Prepare, pretreat, and apply the coating to exposed metal surfaces in accordance with coating and resin manufacturers' written instructions.
4. Fluoropolymer 3-Coat System:
 - a. Provide the manufacturer's standard 3-coat, thermo-cured system complying with the requirements specified in Section 09961, Fluoropolymer Coatings.
 - b. Color:



- 1) Provide a color matching samples selected by the Program/Project Manager from the manufacturer's full range.

2.04 ACCESSORIES

A. Asphalt Roofing Cement:

1. Provide asbestos free asphalt roofing cement complying with the requirements specified in ASTM D 4586, and of a consistency required for the application.

B. Burning Rod for Lead:

1. Provide burning rods for lead having the same composition as the lead sheet.

C. Solder:

1. Except for stainless steel, provide solder complying with the requirements for Grade Sn50 as specified in ASTM B 32.
 - a. Provide rosin flux for use with the solder.
2. For stainless steel, provide solder complying with the requirements for Grade Sn60 as specified in ASTM B 32, and having acid flux of the type recommended by the stainless-steel sheet manufacturer.

D. Fasteners:

1. Provide fasteners of the same metal as the flashing/sheet metal, or of other non-corrosive metal, as recommended by the sheet manufacturer.
2. Match the finish of exposed heads with the material being fastened.
3. Provide wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand the design loads.
 - a. Exposed Fasteners:
 - 1) For exposed fasteners, provide fasteners having plastic caps or factory-applied coating on their heads matching the color of the sheet metal.
 - b. Fasteners for Flashing and Trim:
 - 1) For fasteners for flashing and trim, provide gasketed, blind fasteners or self-drilling screws having a hex washer head.
 - c. Blind Fasteners:
 - 1) For blind fasteners, provide high-strength aluminum or stainless-steel rivets.

E. Bituminous Coating:

1. Provide cold-applied asphalt mastic complying with the requirements specified in SSPC-Paint 12, and compounded so it produces a per coat dry film thickness of 15 mils.
2. Provide an inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.



- F. Bituminous Mastic:
 - 1. Provide solvent-type bituminous mastic complying with the requirements specified in SSPC-Paint 12, nominally free of sulfur, and containing no asbestos fibers.
 - 2. Compound the bituminous mastic so it produces a 15 mil dry film thickness for each coat.
- G. Mastic Sealant:
 - 1. Provide polyisobutylene; non-hardening, non-skinning, nondrying, non-migrating mastic sealant.
- H. Elastomeric Sealant:
 - 1. Provide elastomeric silicone polymer sealant complying with requirements for joint sealants of the type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and make them watertight specified in ASTM C 920 and Section 07920, Joint Sealants.
 - a. Provide a generic type of elastomeric sealant as recommended by the sheet metal manufacturer and fabricator of the components being sealed.
- I. Epoxy Seam Sealer:
 - 1. Provide a 2-part, noncorrosive, aluminum seam-cementing compound, recommended by the aluminum manufacturer for exterior and interior nonmoving joints, including riveted joints.
- J. Sealing Tape:
 - 1. Provide pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape having a release-paper backing.
 - 2. Provide permanently elastic, non-sag, nontoxic, non-staining tape.
- K. Adhesives:
 - 1. Provide adhesives of the type recommended by the flashing sheet metal manufacturer for waterproof and weather-resistant seaming, and adhesive application of flashing sheet metal.
- L. Metal Accessories:
 - 1. Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work.
 - a. Provide metal accessories matching or compatible with the material being installed.
 - b. Provide noncorrosive metal accessories.
 - c. Provide metal accessories of the size and thickness required to produce the specified performance.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the sheet metal flashing and trim installer present, examine the substrates, areas, and conditions to verify the actual locations, dimensions, and other conditions affecting performance of Work.
 - a. Verify that the substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - b. Verify the shapes and dimensions of surfaces to be covered before fabricating sheet metal products.
 - c. Verify that roof openings, curbs, pipes, sleeves, ducts, and vents through the roof are solidly set; and that nailing strips are properly located.
 - d. Verify that roofing termination and base flashings are in place, sealed, and secure.
- B. Evaluation and Assessment:
 - 1. Proceed to install sheet metal flashing and trim only after unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Install the starter and edge strips and the cleats before starting to install sheet metal flashing and trim.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mils.

3.03 INSTALLATION

- A. Unless otherwise indicated, install sheet metal flashing and trim in compliance with the specified performance requirements, the manufacturer's installation instructions, and the SMACNA Architectural Sheet Metal Manual.
 - 1. Using the methods indicated in the referenced requirements, instructions, and standard, securely anchor the units for the Work of this Section in place.
 - 2. Set sheet metal flashing and trim true to line and level as indicated in the Contract Documents.
 - 3. Install sheet metal flashing and trim to fit the substrates, and so the result is watertight performance.
 - 4. Provide fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete the sheet metal flashing and trim system.
 - 5. Install sheet metal flashing materials and fabrications in a manner that prevents bending, warping, twisting, and surface damage.



6. Install exposed sheet metal flashing and trim without producing excessive oil canning, buckling, and tool marks on the materials.
 7. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Laps, Joints, and Seams:
1. Install the Work so the laps, joints, and seams will be permanently watertight and weatherproof.
 - a. Seal joints with elastomeric sealant to produce watertight construction.
 - 1) Prepare the joints, and apply sealants in accordance with the requirements specified in Section 07920, Joint Sealants.
 - b. Where sealant-filled joints are used, form the joints so the sealant is completely concealed.
 2. Provide uniform, neat seams having keeping exposure of solder, welds, and elastomeric sealant to a minimum.
 3. Aluminum Flashing:
 - a. Where it is necessary to produce the required strength in uncoated aluminum, rivet or weld the joints.
- C. Fastening:
1. Anchor the sheet metal flashing and trim and other components of the Work securely in place, with allowances for thermal and structural movement.
 2. Provide the size fastener that will penetrate the substrate not less than 1-1/4 inches for nails, and not less than 3/4 inch for wood screws.
 - a. Galvanized or Pre-painted, Metallic-Coated Steel:
 - 1) For galvanized or pre-painted metallic-coated steel, provide stainless-steel fasteners.
 - b. Aluminum:
 - 1) For aluminum, provide aluminum or stainless steel fasteners.
 - c. Stainless Steel:
 - 1) For stainless steel, provide stainless-steel fasteners.
 3. Where possible, conceal the fasteners.
 4. Space cleats not more than 12 inches apart.
 5. Anchor each cleat with two fasteners.
 6. Bend tabs over fasteners.
- D. Soldered Joints:
1. Do not solder pre-painted, metallic-coated steel and aluminum sheet.
 2. Clean the surfaces to be soldered to remove oils and foreign matter.
 3. Except where pre-tinned surface would show in finished Work, pre-tin the edges of the sheets to be soldered to a width of 1-1/2 inches.
 4. Do not use open-flame torches for soldering.
 - a. Heat the surfaces to receive solder, and flow solder into the joints.
 - b. Fill the joints completely.
 - c. Completely remove flux and spatter from exposed surfaces.
 5. Stainless-Steel Soldering:



- a. Pre-tin the edges of uncoated sheets to be soldered using the solder recommended for stainless steel and phosphoric acid flux.
 - b. Promptly wash off acid flux residue from the metal after soldering.
- E. Installing Reglets:
 1. Install reglets to accommodate counterflashing in manner and by using the methods indicated.
 2. Install surface mounted reglets true to lines and levels.
 3. Seal the top of the reglets with sealant.
- F. Installing Counterflashings:
 1. Install counterflashings in reglets and/or receivers.
 2. Securely snap counterflashings into place using sealant, cleats, and/or other attachment devices; and apply lead wedges and sealant, an interlocking folded seam, or blind rivets and sealant to produce a waterproof installation.
- G. Wall Flashing:
 1. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with the recommendations in the SMACNA Architectural Sheet Metal Manual and as indicated in the Contract Documents.
 2. Openings Flashing in Frame Construction:
 - a. Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.
- H. Roof Flashing:
 1. Copings:
 - a. Anchor copings to resist uplift and outward forces in accordance with the recommendations for the specified wind zone in FMG Loss Prevention Data Sheet 1-49, and as indicated in the Contract Documents.
 - b. Interlock the exterior bottom edge of the coping with continuous cleats anchored to the substrate at 16-inch centers.
 - c. Anchor interior leg of coping using screw fasteners and washers at 18-inch centers.
 2. Counterflashing:
 - a. Coordinate the installation of counterflashing with the installation of the base flashing.
 - b. Insert counterflashing in reglets or receivers, and fit it tightly to the base flashing.
 - c. Extend counterflashing 4 inches over the base flashing.
 - d. Butt the counterflashing joints with a backing plate that is at least 12 inches wide, and bed the counterflashing joints using elastomeric sealant.



- e. Secure the counterflashing joints in a waterproof using anchors and washers at 36-inch centers.
- 3. Roof-Penetration Flashing:
 - a. Seal and clamp flashing to pipes penetrating the roof, except for lead flashing on vent piping.
- I. Roof-Drainage System:
 - 1. To drain the roof in the most efficient manner, install those drainage items fabricated from sheet metal using straps, adhesives, and/or anchors as recommended by the SMACNA Architectural Sheet Metal Manual or the item's manufacturer.
- J. Equipment Support Flashing:
 - 1. Weld or seal with elastomeric sealant the equipment support flashing to the equipment support member.
- K. Special Techniques:
 - 1. Expansion Provisions:
 - a. Provide thermal expansion provisions for exposed sheet metal Work as specified herein.
 - b. Space movement joints a maximum of 10 feet apart with no joints allowed within 24 inches of a corner or intersection.
 - 2. Metal Protection:
 - a. Where dissimilar metals will contact each other or corrosive substrates, protect the sheet metal flashing and trim against galvanic action by painting the contact surfaces with a bituminous coating or by other permanent separation as recommended by the fabricator or manufacturers of the dissimilar metals.
 - b. Coat the side of the uncoated aluminum and stainless-steel sheet metal flashing and trim where the flashing and trim will contact wood, ferrous metal, or cementitious construction with bituminous coating.
 - c. Underlayment:
 - 1) Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover it with a slip sheet, or install a course of polyethylene underlayment.
 - d. Where required to furnish the required waterproof performance, bed the flanges in a thick coat of asphalt roofing cement.

3.04 REPAIR/RESTORATION

- A. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.



3.05 CLEANING

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed.
- B. Clean exposed metal surfaces to remove substances that might cause corrosion of the metal, interfere with uniform oxidation and weathering, or deterioration of the finishes.
 - 1. Clean and neutralize flux materials.
 - 2. Clean off excess solder and sealants.
- C. On completion of sheet metal flashing and trim installation, clean the finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing.
 - 1. Maintain the sheet metal flashing and trim in a clean condition during construction.

3.06 PROTECTION

- A. During construction, provide protection and maintain the conditions that ensure that sheet metal flashing and trim Work is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A, 1.02.C.8, 1.04.B.2, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System





SECTION 07720

ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following roof accessories:
 - a. Roof curbs.
 - b. Equipment supports.
 - c. Roof hatches.
 - d. Hatch-type heat and smoke vents.
 - e. Dropout-type heat and smoke vents.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. PVDF: Polyvinylidene fluoride.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Counterflashing: Formed metal sheeting secured to walls, curbs, or other surfaces, for use in protecting the top edge of base flashings from exposure to weather.
 - 3. Polyvinylidene Fluoride: A highly non-reactive and pure thermoplastic fluoropolymer, also known as Kynar, Hylar, or Sygef.
- C. Reference Standards:
 - 1. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
 - b. AAMA 620 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates.
 - c. AAMA 621 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.



- d. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
 2. American Wood Protection Association (AWPA):
 - a. AWPA T1 – Use Category System: Processing and Treatment Standard.
 - b. AWPA U1 – Use Category System: User Specification for Treated Wood.
 3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 240/A 240M - Standard Specification for Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - d. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - e. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
 - f. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - g. ASTM A 792/A 792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - h. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - i. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - j. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - k. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - l. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
 - m. ASTM D 256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - n. ASTM D 4802 – Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet.
 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 5. FM Approvals LLC (FM):



- a. FM Class Number 2031 – Approval Standard for Heat Responsive Links for Fire Protection.
 - b. FM Class Number 4430 – Approval Standard for Heat and Smoke Vents.
 - c. The Approval Guide, www.approvalguide.com.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. Underwriters Laboratories, Inc.® (UL):
 - a. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - b. UL 793 - Standard for Automatically Operated Roof Vents for Smoke and Heat.
 - c. UL 972 - Standard for Burglary Resisting Glazing Material.
8. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 - Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 2. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) Roof plans.
 - b) Roof penetrations.
 - c) Roof-mounted items.
- B. Sequencing:
 1. Complete support framing for roof accessories and roof decking before commencing to install the roof accessories.
 2. Install counterflashing after the roofing has been installed.

1.04 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Roof curbs.
 - 2) Equipment supports.
 - 3) Roof hatches.
 - 4) Hatch-type heat and smoke vents.
 - 5) Dropout-type heat and smoke vents.
 - b. Shop Drawings:
 - 1) Roof curbs.
 - 2) Equipment supports.
 - 3) Roof hatches.
 - 4) Hatch-type heat and smoke vents.
 - 5) Dropout-type heat and smoke vents.
 - 6) Coordination Drawings:
 - c. Samples:
 - 1) Samples of each exposed product provided under this Section.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Roof accessory manufacturers' written installation instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for each roof accessory provided under this Section.
 - b. Warranty Documentation:
 - 1) Painted Finishes Warranty.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.



- b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved.
- c. Both continuous and periodic Special Inspections will be performed during the erection of unit masonry assemblies.
- 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
 - b. Other qualified testing and inspecting agencies acceptable to the Authorities Having Jurisdiction, such as Underwriters Laboratories, Inc. (UL) and FM Approvals LLC, perform testing and follow-up inspections of systems.
 - 1) Underwriters Laboratories, Inc. (UL) Fire Resistance Directory:
 - a) Underwriters Laboratories, Inc. publishes a Fire Resistance Directory which lists all assemblies, systems, and devices UL has tested, and classifies them under Category Codes (CCN) in the UL Online Certifications Directory.
 - 2) FM Approvals LLC (FM) Listing:
 - a) FM Approvals LLC (FM) furnishes a free online service, The Approval Guide, listing approved assemblies complying with various FM Approval Standards.

B. Site Samples:

- 1. Submit Samples for each exposed product provided under this Section, and of each color and texture specified to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.

B. Storage and Handling Requirements:

- 1. Store roof accessories on blocking or other supports to prevent contact with dirt, debris, and moisture.
 - a. Protect ferrous roof accessories from exposure to conditions that produce rust.
- 2. Handle roof accessories so no parts are bent, broken, or otherwise damaged; and avoid damage to other material and work.



- a. Exercise care to avoid scraping and over stressing the metal.
 - b. Replace bent or damaged pieces, unless the Program/Project Manager authorizes repairs.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Special Warranty:
 - 1. Painted Finishes Warranty:
 - a. Furnish a Painted Finishes Warranty on the manufacturer's standard form in which the manufacturer agrees to repair finishes or replace roof accessories that show evidence of the deterioration of factory-applied finishes within 20 years from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Description:
 - 1. Regulatory Requirements:
 - a. Roof Hatch Safety Railing Systems:
 - 1) For all roof hatches, provide a safety railing system complying with the requirements specified in 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes, and with the requirements of the Authorities Having Jurisdiction.
- B. Design Criteria:
 - 1. Provide the materials, types of fasteners, protective coatings, sealants, and other miscellaneous items required by the roof accessory manufacturer to provide a complete installation.
 - 2. Heat and Smoke Vent Standard:
 - a. Provide heat and smoke vents that have been tested and UL-listed in the UL Fire Resistance Directory as complying with the requirements specified in UL 793 and are FM Approved in accordance with the requirements specified in FM Class Number 4430.
 - 3. Product Data:
 - a. Submit Product Data for each type of roof accessory provided under this Section to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Submit Shop Drawings for the roof accessories provided under this Section to the Program/Project Manager for approval.



C. Materials:

1. Metal Materials:

a. Zinc-Coated (Galvanized) Steel Sheet:

- 1) Provide zinc-coated (galvanized) steel sheet complying with the requirements specified for the G90 (Z275) coating designation in ASTM A 653/A 653M; and having the finish indicated in the Contract Documents complying with the following:
 - a) Mill-Phosphatized Finish:
 - (1) Provide a mill-phosphatized finish in accordance with the manufacturer's standard for field painted galvanized steel sheet.
 - b) Factory Prime Coating:
 - (1) Where field painting is indicated in the Contract Documents, apply a pretreatment and a white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum 0.2 mil (0.005mm) dry film thickness.
 - c) Exposed Coil-Coated Finish:
 - (1) Provide a two-coat fluoropolymer finish system consisting of a primer and a fluoropolymer color topcoat complying with the requirements specified in AAMA 621; and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 - d) Baked-Enamel or Powder-Coat Finish:
 - (1) Provide the manufacturer's standard two-coat, baked-on finish consisting of a prime coat and a thermosetting topcoat, with a minimum 1 mil (0.025mm) topcoat dry film thickness.

b. Aluminum-Zinc Alloy-Coated Steel Sheet:

- 1) Provide aluminum-zinc alloy-coated steel sheet complying with the requirements for AZ50 (AZM150) coated material specified in ASTM A 792/A 792M; and having the finish indicated in the Contract Documents complying with the following:
 - a) Factory Prime Coating:
 - (1) Where field painting is indicated in the Contract Documents, apply a pretreatment and a white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum 0.2 mil (0.005mm) dry film thickness.
 - b) Exposed Coil-Coated Finish:
 - (1) Provide a two-coat fluoropolymer finish system consisting of a primer and a fluoropolymer color topcoat complying with the requirements specified in AAMA 621; and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 - c) Baked-Enamel or Powder-Coat Finish:



- (1) Provide the manufacturer's standard two-coat, baked-on finish consisting of a prime coat and a thermosetting topcoat, with a minimum 1 mil (0.025mm) topcoat dry film thickness.
- c. Aluminum Sheet:
 - 1) Provide aluminum sheet complying with the requirements specified in ASTM B 209 (ASTM B 209M), of the manufacturer's standard alloy for the finish required, having the temper to suit the forming operations and performance required; and having the finish indicated in the Contract Documents complying with the following:
 - a) Mill Finish:
 - (1) Provide aluminum sheet having the mill finish as Manufactured.
 - b) Factory Prime Coating:
 - (1) Where field painting is indicated in the Contract Documents, apply a pretreatment and a white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum 0.2 mil (0.005mm) dry film thickness.
 - c) Clear Anodic Finish:
 - (1) Provide aluminum sheet having a 0.010mm or thicker clear anodic finish complying with the requirements for a Class II finish specified in AAMA 611.
 - d) Color Anodic Finish:
 - (1) Provide aluminum sheet having a 0.010mm or thicker color anodic finish complying with the requirements for a Class II finish specified in AAMA 611.
 - e) Exposed Coil-Coated Finish:
 - (1) Provide a two-coat fluoropolymer finish system consisting of a primer and a fluoropolymer color topcoat complying with the requirements specified in AAMA 620; and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 - f) Baked-Enamel or Powder-Coat Finish:
 - (1) Provide a baked-enamel or powder-coat finish complying with the requirements specified in AAMA 2603, except having a minimum 1.5 mils (0.04mm) dry film thickness.
- d. Aluminum Extrusions and Tubes:
 - 1) Provide aluminum extrusions and tubes complying with the requirements specified in ASTM B 221 (ASTM B 221M), of the manufacturer's standard alloy and temper for the type of use; and finished to match the assembly where used
 - a) If aluminum extrusions and tubes are not finished to match the assembly where used, provide mill-finished extrusions and tubes.



- e. Stainless-Steel Sheet and Shapes:
 - 1) Provide stainless-steel sheet and shapes complying with the requirements specified in ASTM A 240/A 240M, or with the requirements for Type 304 stainless-steel specified in ASTM A 666.
- f. Steel Shapes:
 - 1) Provide steel shapes complying with the requirements specified in ASTM A 36/A 36M; and, unless otherwise indicated in the Contract Documents, hot-dip galvanized in accordance with the requirements specified in ASTM A 123/A 123M.
- 2. Glazing:
 - a. Acrylic Glazing:
 - 1) Provide the manufacturer's standard thermoformable, monolithic sheet, acrylic glazing complying with the requirements for Type UVA (formulated with UV absorber), Finish 1 (smooth or polished) acrylic sheet specified in ASTM D 4802.
 - b. Polycarbonate Glazing:
 - 1) Provide thermoformable, monolithic polycarbonate sheets manufactured using the extrusion process.
 - 2) Provide polycarbonate sheets rated burglar-resistant in accordance with the requirements specified in UL 972, and having an average impact strength of 12 to 16 pounds force per square inch (640J/m to 854J/m) of width when tested in accordance with Method A (Izod) specified in ASTM D 256.
- 3. Wood Nailers:
 - a. Provide softwood lumber wood nailers.
 - b. Preservative:
 - 1) Pressure treat the wood nailers with waterborne preservatives complying with the requirements specified in AWPA T1 and AWPA U1, acceptable to the Authorities Having Jurisdiction (AHJ) for aboveground use, and containing no arsenic or chromium.
 - c. Thickness:
 - 1) Provide wood nailers not less than 1-1/2 inches (38mm).
- 4. Security Grills:
 - a. Provide 3/4-inch (19-mm) diameter security grills complying with the requirements specified in ASTM A 1011/A 1011M, and consisting of steel bars spaced 6 inches (150mm) apart on center in one direction and 12 inches (300mm) apart on center in a direction at right angles to the first.
 - b. Factory-finish the security grills with the manufacturer's or fabricator's standard, universal shop primer compatible with the substrate and the field-applied finish paint system specified in Section 09960, High-Performance Coatings.
- 5. Fasteners:



- a. Provide the roof accessory manufacturer's recommended fasteners suitable for the application and the metals being fastened.
 - b. Match the finish of exposed fasteners with the finish of the material being fastened.
 - c. For exterior exposed fasteners, provide non-removable fastener heads.
6. Sealants:
- a. Provide sealants as recommended by the roof accessory manufacturer for the installation indicated in the Contract Documents.

D. Roof Curbs:

- 1. Provide internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on the Contract Drawings.
 - a. Provide roof-curb units having integral spring-type vibration isolators.
- 2. Provide roof-curb units fabricated from zinc-coated (galvanized) steel sheet, aluminum-zinc alloy-coated steel sheet, aluminum sheet, or stainless-steel sheet as follows:
 - a. Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet:
 - 1) Thickness: 0.079 inch (2.01mm).
 - 2) Finish: Two-coat fluoropolymer.
 - 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - b. Aluminum Sheet:
 - 1) Thickness: 0.090 inch (2.28mm).
 - 2) Finish: Two-coat fluoropolymer.
 - 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - c. Stainless-Steel Sheet:
 - 1) Thickness: 0.078 inch (1.98mm).
 - 2) Finish: Manufacturer's standard.
- 3. Roof Curb Construction:
 - a. Roof Curb Assembly:
 - 1) Weld or mechanically fasten and seal the corner joints, the stepped integral metal cant raised the thickness of the roof insulation, and the integrally formed deck-mounting flange at the perimeter bottom.
 - b. Top Surface:
 - 1) Provide a level top surface around the perimeter of the roof curb.
 - 2) Provide a continuous factory-installed wood nailer around the perimeter on the top of the curb.
 - c. Roof Curb Height:
 - 1) Unless otherwise indicated, fabricate roof curbs a minimum of 12 inches (300mm) high.
 - d. Insulation:



- 1) Provide factory-installed 1-1/2-inch (38mm) thick polyisocyanurate board insulation in the roof curb.
- e. Liner:
 - 1) Provide a liner of the same material as the curb, and having the manufacturer's standard thickness and finish.
- f. Roof Curbs for Ribbed or Fluted Roofs:
 - 1) For roof curbs to be installed on ribbed or fluted metal roofs, form the deck-mounting flange at perimeter of the bottom of the roof curb to conform to the roof profile.
- g. Roof Curbs for Sloping Roofs:
 - 1) Accommodate roof slopes by sloping the deck-mounting flange.
 - a) On the side of the unit that obstructs water flow, provide a water diverter or cricket.
 - 2) Where slope or roof deck exceeds 1:48, taper the curb height of the perimeter to accommodate the roof slope so the top perimeter surface of the curb is level.
- h. Security Grille:
 - 1) Provide a security grille where indicated in the Contract Drawings.
4. Manufacturers:
 - a. AES Industries, Inc., www.aescurb.com.
 - b. Curbs Plus, Inc., www.curbs-plus.com.
 - c. Custom Solution Roof and Metal Products, www.csroofmetalproducts.com.
 - d. Greenheck Fan Corporation, www.greenheck.com.
 - e. LM Curbs, www.lmcurbs.com.
 - f. Metallic Products Corp, www.mpvent.com.
 - g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc, www.milcorinc.com.
 - h. Pate Company (The), www.patecurbs.com.
 - i. Roof Products, Inc, www.rpicurbs.com.
 - j. Safe Air of Illinois, www.safeair-dowco.com.
 - k. Thybar Corporation, www.thybar.com.
 - l. Vent Products Co., Inc, www.ventproducts.com.
 - m. Approved equal.
- E. Equipment Supports:
 1. Provide internally reinforced metal equipment supports capable of supporting the superimposed live and dead loads, including equipment loads and other construction indicated on the Contract Drawings.
 2. Provide equipment supports fabricated from zinc-coated (galvanized) steel sheet, aluminum-zinc alloy-coated steel sheet, aluminum sheet, or stainless-steel sheet as follows:
 - a. Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet:
 - 1) Thickness: 0.079 inch (2.01mm).
 - 2) Finish: Two-coat fluoropolymer.



- 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - b. Aluminum Sheet:
 - 1) Thickness: 0.090 inch (2.28mm).
 - 2) Finish: Two-coat fluoropolymer.
 - 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - c. Stainless-Steel Sheet:
 - 1) Thickness: 0.078 inch (1.98mm).
 - 2) Finish: Manufacturer's standard.
3. Equipment Support Construction:
 - a. Equipment Support Assembly:
 - 1) Weld or mechanically fasten and seal the corner joints the stepped integral metal cant raised the thickness of the roof insulation, and the integrally formed deck-mounting flange at the perimeter bottom.
 - b. Top Surface:
 - 1) Provide a factory-installed 5-1/2 inch (140mm) wide wood nailer continuously around the top of the equipment support.
 - c. Equipment Support Height:
 - 1) Unless otherwise indicated, fabricate equipment supports a minimum of 12 inches (300mm) high.
 - d. Insulation:
 - 1) Provide factory-installed 1-1/2-inch (38mm) thick polyisocyanurate board insulation in the roof curb.
 - e. Liner:
 - 1) Provide a liner of the same material as the equipment support, and having the manufacturer's standard thickness and finish.
 - f. Counterflashing:
 - 1) Provide the manufacturer's standard removable, metal counterflashing, fabricated of the same metal and having the same finish as the equipment support.
 - g. Equipment Supports for Ribbed or Fluted Roofs:
 - 1) For equipment supports to be installed on ribbed or fluted metal roofs, form the deck-mounting flange at perimeter of the bottom of each equipment support to conform to the roof profile.
 - h. Equipment Supports for Sloping Roofs:
 - 1) Where the slope or roof deck exceeds 1:48, fabricate each support to have a height accommodating the roof slope so that the tops of the supports are level with each other.
 - 2) On the side of the equipment support that obstructs water flow, provide a water diverter or cricket.
 - i. Security Grille:
 - 1) Provide security grilles where indicated in the Contract Drawings.
4. Manufacturers:



- a. AES Industries, Inc., www.aescurb.com.
- b. Curbs Plus, Inc, www.curbs-plus.com.
- c. Custom Solution Roof and Metal Products, www.csroofmetalproducts.com.
- d. Greenheck Fan Corporation, www.greenheck.com.
- e. LM Curbs, www.lmcurbs.com.
- f. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc, www.milcorinc.com.
- g. Pate Company (The), www.patecurbs.com.
- h. Roof Products, Inc, www.rpicurbs.com.
- i. Thybar Corporation, www.thybar.com.
- j. Vent Products Co., Inc, www.ventproducts.com.
- k. Approved Equal.

F. Roof Hatch:

- 1. Provide metal roof-hatches having lids and insulated single-walled curbs of the following type(s) and size(s):
 - a. Single-Leaf Lid:
 - 1) Size: 30 inches by 36 inches (750mm by 900mm).
 - 2) Size: 48 inches by 144 inches
 - b. Double-Leaf Lid:
 - 1) Size: 72 inches by 96 inches (1830mm by 2440mm).
- 2. Roof Hatch Loads:
 - a. External Live Load: 40 pounds force per square foot (1.9kPa).
 - b. Internal Uplift Load: 20 pounds force per square foot (0.95kPa).
 - c. Dome Glazing Loads:
 - 1) External Live Load: 40 pounds force per square foot (1.9kPa).
 - 2) Internal Uplift Load: 20 pounds force per square foot (0.95kPa).
- 3. Provide roof-hatches fabricated from zinc-coated (galvanized) steel sheet, aluminum-zinc alloy-coated steel sheet, aluminum sheet, or stainless-steel sheet as follows:
 - a. Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet:
 - 1) Thickness: 0.079 inch (2.01mm).
 - 2) Finish: Two-coat fluoropolymer.
 - 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - b. Aluminum Sheet:
 - 1) Thickness: 0.090 inch (2.28mm).
 - 2) Finish: Two-coat fluoropolymer.
 - 3) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - c. Stainless-Steel Sheet:
 - 1) Thickness: 0.078 inch (1.98mm).
 - 2) Finish: Manufacturer's standard.
- 4. Roof Hatch Construction:



- a. Roof Hatch Assembly:
 - 1) Weld or mechanically fasten and seal the corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, the stepped integral metal cant raised the thickness of the roof insulation, and the integrally formed deck-mounting flange at the perimeter bottom.
- b. Roof Hatch Height:
 - 1) Unless otherwise indicated, fabricate curbs a minimum of 12 inches (300mm) high.
- c. Insulation:
 - 1) Provide polyisocyanurate board insulation.
- d. Roof Hatch Lid:
 - 1) Provide opaque, insulated, double walled roof hatch lids having the manufacturer's standard metal liner of the same material and finish as the outer metal lid.
- e. Curb Liner:
 - 1) Provide a curb liner of the same material as the metal curb, and having the manufacturer's standard thickness and finish.
- f. Roof Hatches for Ribbed or Fluted Roofs:
 - 1) For roof hatches to be installed on ribbed or fluted metal roofs, form the flange at the perimeter of the bottom of each roof hatch to conform to the roof profile.
- g. Roof Hatches for Sloping Roofs:
 - 1) Where the slope or roof deck exceeds 1:48, fabricate the curb to have a perimeter height tapered to accommodate the roof slope so that the top surfaces of perimeter curb are level.
 - 2) On the side of the equipment support that obstructs water flow, provide a water diverter or cricket.
- h. Roof Hatch Lid Glazing:
 - 1) Provide double hatch lid glazing having a thickness capable of resisting the loads indicated in the Contract Documents.
 - a) Single-Dome Color:
 - (1) Provide white, translucent single dome hatch lid glazing.
 - b) Outer Double-Dome Color:
 - (1) Provide white, translucent outer double-dome hatch lid glazing.
 - c) Inner Double-Dome Color:
 - (1) Provide white, translucent inner double-dome hatch lid glazing.
- i. Hardware:
 - 1) Provide hardware for the roof hatch lids having a galvanized-steel spring latch with turn handles, a butt- or pintle-type hinge system, and padlock hasps on both the inside and outside.
 - a) Provide a two-point latch on lids larger than 84 inches (2130mm).



- b) Provide remote-control operation for the roof hatch lid hardware.
 - j. Safety Railing System:
 - 1) Provide the roof-hatch manufacturer's standard safety railing system attached to the roof hatch, including the rails, clamps, fasteners, a safety barrier at the railing opening, and the other accessories required for a complete installation
 - k. Ladder-Assist Post:
 - 1) Provide the roof-hatch manufacturer's standard device for attachment to roof-access ladders.
 - 2) Provide post locks in place on the full ladder-assist post extension; and a release mechanism that returns the post to its closed position.
- 5. Manufacturers:
 - a. AES Industries, Inc., www.aescurb.com.
 - b. Babcock-Davis, www.babcockdavis.com.
 - c. Bilco Company (The), www.bilco.com.
 - d. Bristolite Skylights, www.bristolite.com.
 - e. Custom Solution Roof and Metal Products, www.csroofmetalproducts.com.
 - f. Dur-Red Products, www.dur-red.com.
 - g. Hi Pro International, Inc, <http://www.hiprintl.com>.
 - h. J.L. Industries, Inc, jindustries.com.
 - i. Metallic Products Corp, www.mpvent.com.
 - j. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc, www.milcorinc.com.
 - k. Naturalite Skylight Systems; Vistawall Group (The), www.vistawall.com.
 - l. Nystrom, nystrom.com.
 - m. O'Keeffe's Inc, www.okeeffes.com.
 - n. Pate Company (The), www.patecurbs.com.
 - o. Precision Ladders, LLC, precisionladders.com.
 - p. Approved Equal.
- G. Heat and Smoke Vents:
 - 1. Hatch-Type Heat and Smoke Vents:
 - a. Provide the manufacturer's standard hatch-type heat and smoke vents having double-walled insulated curbs, welded or mechanically fastened and sealed corner joints, an integral condensation gutter, and cap flashing.
 - b. Lids and Gaskets:
 - 1) Provide each hatch-type heat and smoke vent with an insulated double-walled lid having a continuous weathertight lid gasket around the perimeter of the lid, and of the following type(s) and size(s):
 - a) Single-Leaf Lid:



- (1) Size: 30 inches by 36 inches (750mm by 900mm).
 - b) Double-Leaf Lid:
 - (1) Size: 72 inches by 96 inches (1830mm by 2440mm).
 - 2) Equip the hatch-type heat and smoke vent with automatic self-lifting mechanisms and a UL-listed smoke-detection system.
- c. Hatch-Type Heat and Smoke Vent Loads:
 - 1) External Live Load: 40 pounds force per square foot (1.9kPa).
 - 2) Internal Uplift Load: 30 pounds force per square foot (1.4kPa).
 - 3) Hatch Release Loads:
 - a) When the hatch release is actuated, the lid must be capable of opening against a 10 pounds force per square foot (0.5kPa) snow or wind load, and of locking in position.
 - 4) Hatch Lid Glazing Loads:
 - a) External Live Load: 40 pounds force per square foot (1.9kPa).
 - b) Internal Uplift Load: 20 pounds force per square foot (0.95kPa).
- d. Provide hatch-type heat and smoke vent curbs, framing, and lids fabricated from zinc-coated (galvanized) steel sheet, aluminum-zinc alloy-coated steel sheet, aluminum sheet, or stainless-steel sheet as follows:
 - 1) Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet:
 - a) Thickness: 0.079 inch (2.01mm).
 - b) Finish: Two-coat fluoropolymer.
 - c) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - 2) Aluminum Sheet:
 - a) Thickness: 0.090 inch (2.28mm).
 - b) Finish: Two-coat fluoropolymer.
 - c) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - 3) Stainless-Steel Sheet:
 - a) Thickness: 0.078 inch (1.98mm).
 - b) Finish: Manufacturer's standard.
- e. Hatch-Type Heat and Smoke Vent Construction:
 - 1) Insulation:
 - a) Provide polyisocyanurate board insulation.
 - 2) Lids:
 - a) Provide opaque, insulated, double walled roof hatch lids having the manufacturer's standard metal liner of the same material and finish as the outer metal lid.
 - 3) Exterior Curb:
 - a) Liner:



- (1) Provide an exterior curb liner of the same material as the metal curb, and having the manufacturer's standard finish.
 - b) Height:
 - (1) Unless otherwise indicated, fabricate curbs a minimum of 12 inches (300mm) high.
 - 4) Hatch-Type Heat and Smoke Vents for Sloping Roofs:
 - a) Where the slope or roof deck exceeds 1:48, fabricate the curb to have a perimeter height tapered to accommodate the roof slope so that the top surfaces of perimeter curb are level.
 - b) On the side of the equipment support that obstructs water flow, provide a water diverter or cricket.
 - 5) Security Grille:
 - a) Provide security grilles where indicated in the Contract Drawings.
 - 6) Hatch-Type Heat and Smoke Vent Lid Glazing:
 - a) Provide double hatch lid glazing having a thickness capable of resisting the loads indicated in the Contract Documents.
 - b) Provide white, translucent hatch lid glazing.
 - 7) Hardware:
 - a) Provide hardware for the hatch-type heat and smoke vent consisting of corrosion resistant or hot-dip galvanized hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
- f. Manufacturers:
 - 1) Babcock-Davis, www.babcockdavis.com.
 - 2) Bilco Company (The), www.bilco.com.
 - 3) Bristolite Skylights, www.bristolite.com.
 - 4) Dur-Red Products, www.dur-red.com.
 - 5) Hi Pro International, Inc, <http://www.hiprointl.com>.
 - 6) J.L. Industries, Inc, jlintdustries.com.
 - 7) Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc, www.milcorinc.com.
 - 8) Naturalite Skylight Systems; Vistawall Group (The), www.vistawall.com.
 - 9) Nystrom, nystrom.com.
 - 10) O'Keeffe's Inc, www.okeeffes.com.
 - 11) Pate Company (The), www.patecurbs.com.
 - 12) Western Canwell, www.westerncanwell.com.
 - 13) Approved Equal.
2. Dropout-Type Heat and Smoke Vents:
 - a. Provide the manufacturer's standard gravity operated, automatic dropout-type heat and smoke vents having double-walled insulated curbs and frame, welded or mechanically fastened and sealed corner joints, an integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of the vent opening



according to the heat and smoke vent standard indicated in Subparagraph 2.01.B.2.

- b. Dropout-Type Heat and Smoke Vent Loads:
 - 1) External Live Load: 40 pounds force per square foot (1.9kPa).
 - 2) Internal Uplift Load: 30 pounds force per square foot (1.4kPa).
 - 3) Dome Glazing Loads:
 - a) External Live Load: 40 pounds force per square foot (1.9kPa).
 - b) Internal Uplift Load: 20 pounds force per square foot (0.95kPa).
- c. Provide dropout -type heat and smoke vent curbs and framing fabricated from zinc-coated (galvanized) steel sheet, aluminum-zinc alloy-coated steel sheet, aluminum sheet, or stainless-steel sheet as follows:
 - 1) Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet:
 - a) Thickness: 0.079 inch (2.01mm).
 - b) Finish: Two-coat fluoropolymer.
 - c) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - 2) Aluminum Sheet:
 - a) Thickness: 0.090 inch (2.28mm).
 - b) Finish: Two-coat fluoropolymer.
 - c) Color: To be selected by the Program/Project Manager from the manufacturer's full range.
 - 3) Stainless-Steel Sheet:
 - a) Thickness: 0.078 inch (1.98mm).
 - b) Finish: Manufacturer's standard.
- d. Dropout-Type Heat and Smoke Vent Construction:
 - 1) Insulation:
 - a) Provide polyisocyanurate board insulation.
 - 2) Exterior Curb:
 - a) Liner:
 - (1) Provide an exterior curb liner of the same material as the metal curb, and having the manufacturer's standard finish.
 - b) Height:
 - (1) Unless otherwise indicated, fabricate curbs a minimum of 12 inches (300mm) high.
 - 3) Dropout-Type Heat and Smoke Vents for Sloping Roofs:
 - a) Where the slope or roof deck exceeds 1:48, fabricate the curb to have a perimeter height tapered to accommodate the roof slope so that the top surfaces of perimeter curb are level.
 - b) On the side of the equipment support that obstructs water flow, provide a water diverter or cricket.
 - 4) Dropout-Type Heat and Smoke Vent Dome Glazing:



- a) Provide double polycarbonate glazing having a thickness capable of resisting the loads indicated in the Contract Documents.
 - (1) Single-Dome Color:
 - (a) Provide white, translucent, single-dome glazing.
 - (2) Outer Double-Dome Color:
 - (a) Provide white, translucent outer double-dome glazing.
 - (3) Inner Double-Dome Color:
 - (a) Provide white, translucent inner double-dome glazing.
- 5) Hardware:
 - a) Provide hardware for the dropout-type heat and smoke vent consisting of corrosion resistant or hot-dip galvanized hinges, hold-open devices, and independent manual-release devices for inside and outside] operation of lids.
- e. Manufacturers:
 - 1) Construction Specialties, Inc. www.c-sgroup.com
 - 2) Naturalite Skylight Systems; Vistawall Group (The), www.vistawall.com.
 - 3) Pate Company (The), www.patecurbs.com.
 - 4) Plasteco, Inc, www.plasteco.com.
 - 5) Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the dimensions of the roof openings for the roof accessories are adequate for installing the accessories.
- B. Evaluation and Assessment:
 - 1. Do not proceed with the Work of this Section until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install roof accessories in accordance with the manufacturer's written instructions.
 - 1. Use fasteners, separators, sealants, and other miscellaneous items as required for completing the installation of the roof accessories, and fit them to the substrates.
 - 2. Submit the roof accessory manufacturers' written installation instructions to the Program/Project Manager for information.
- B. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.



- C. Anchor roof accessories securely in place so they are capable of resisting the loads specified.
- D. Install roof accessories so they are capable of being exposure to the weather without failing, rattling, leaking, or having fasteners and seals loosening.
- E. Seal joints with sealant as required by the roof accessory manufacturer.
- F. Special Techniques:
 - 1. Security Grilles:
 - a. Weld bar intersections and, either by welding or using tamper-resistant bolts, attach the ends of the bars to the structural frame or primary curb walls.
- G. Interface with Other Work:
 - 1. Metal Protection:
 - a. Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting the contact surfaces with a bituminous coating, or by using another permanent separation as recommended by manufacturer.
 - b. Coat the concealed side of uncoated aluminum and stainless-steel roof accessories with a bituminous coating where they are in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment:
 - a. Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment; and cover the underlayment with a slip sheet, or install a course of polyethylene sheet.

3.03 REPAIR/RESTORATION

- A. Galvanized Surface Repairs:
 - 1. Clean field welds, bolted connections, and abraded areas, and repair galvanizing, in accordance with the requirements specified in ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer so they are ready for field painting in accordance with the requirements specified in Section 09960, High-Performance Coatings.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period after roof accessories have been installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of the units.



- a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Inspections:
- a. Smoke Control Systems:
 - 1) The Phoenix Building Construction Code and Amendments and Section 1704.14, Smoke Control Special Inspections, of the ICC International Building Code (IBC) as Amended by the City of Phoenix requires Special Inspections of heat and smoke vents to be performed.
- B. Non-Conforming Work
1. Remove roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, and replace them with roof accessories complying with the requirements specified.

3.05 CLEANING

- A. Waste Management:
1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 MAINTENANCE

- A. Submit operation and maintenance data for each roof accessory provided under this Section to the Program/Project Manager.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 07810

APPLIED FIREPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for furnishing and applying fireproofing onto structural steel members provided under Section 05120, Structural Steel, where indicated on the Contract Drawings.
 - 2. Requirements for furnishing and applying fireproofing onto the underside of steel decking provided under Section 05310, Steel Deck, where indicated on the Contract Drawings.
 - 3. Requirements for topcoats.
 - 4. Requirements for sealers.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 05120 – Structural Steel.
 - 5. Section 05310 – Steel Deck.
 - 6. Section 07850 – Through Penetration Firestopping Systems.

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - b. ASTM E 136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.



- c. ASTM E 605 - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
- d. ASTM E 736 - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
- e. ASTM E 759 - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
- f. ASTM E 760 - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members.
- g. ASTM E 761 - Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members.
- h. ASTM E 859 - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRM) Applied to Structural Members.
- i. ASTM E 937 - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
- j. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- 2. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 3. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
- 4. United States Government (US):
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 763 - Asbestos.
 - b. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the application of sprayed fire-resistive material with other construction to minimize the need to cut or remove fire protection.
 - a. Coordinate the Work of this Section with the placement of ceiling hanger tabs, mechanical component hangers, and electrical components.
 - 2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.



3. Coordinate the Work of this Section with the Work of Section 07850, Through Penetration Firestopping Systems.
- B. Pre-Installation Meetings:
 1. Convene a pre-installation meeting one week prior to commencing the Work of this Section in accordance with the requirements of Section 01316, Project Meetings.
- C. Sequencing:
 1. Sequence and coordinate application of sprayed fire-resistive materials with other related work specified in other Sections to comply with the following requirements:
 - a. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
 - b. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 - c. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
 - d. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, and tested; and corrections have been made to defective applications.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Provide Data for each product provided under this Section.
 - b. Certificates:
 - 1) Fireproofing Manufacturer's Certification.
 - c. Special Procedure Submittals:
 - 1) Special procedures required to deliver, handle, and/or apply the fireproofing.
 - d. Qualification Statements:
 - 1) Applied fireproofing manufacturer's qualifications.
 - 2) Applied fireproofing applicator's qualifications.
- B. Informational Submittals:
 1. Submit the following to the Project/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Test and Evaluation Reports:
 - 1) Bond strength test reports from reputable independent testing agencies.
 - 2) Bond impact test reports from reputable independent testing agencies.
 - 3) Compressive strength test reports from reputable independent testing agencies.
 - 4) Fire test reports from reputable independent testing agencies.
 - b. Manufacturer's Instructions:
 - 1) Bonding agent application instructions from the fireproofing manufacturer.
 - 2) Primer adhesive application instructions from the fireproofing manufacturer.
 - c. Site Quality Control Submittals:
 - 1) Environmental conditions under which fireproofing materials were applied.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
- a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
- C. Closeout Submittals:
- 1. Submit the following to the Project/Project Manager for approval in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Fireproofing Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Asbestos:



- a. Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy".
- B. Qualifications:
 - 1. Manufacturer Qualifications:
 - a. Obtain the products for the Work of this Section from a company specializing in manufacturing applied fireproofing products and that has at least 3 years of documented experience producing applied fireproofing of the type required by this Section.
 - b. Submit the manufacturer's qualifications to the Program/Project Manager for approval.
 - 2. Applicator Qualifications:
 - a. Employ an applicator certified, licensed, or otherwise qualified by the applied fireproofing material manufacturer and who specializes in applying fireproofing products, has sufficient trained staff to install the manufacturer's products according to the requirements specified, and who has at least 3 years of documented experience applying fireproofing of the type required by this Section.
 - 1) Provide engineering services for designating restrained and unrestrained conditions.
 - b. Submit the applicator's qualifications to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Fireproofing Manufacturer's Certification:
 - a. Submit a written Fireproofing Certification from the fireproofing manufacturer certifying that the sprayed-on fireproofing products provided under this Section meet or exceed the requirements specified herein.
- D. Mock-Ups:
 - 1. Fireproofing Mock-Up:
 - a. Construct a mock-up at least 3 feet long by 3 feet wide to illustrate the application and appearance of the fireproofing.
 - b. Conform the mock-up to Project requirements for fire ratings.
 - c. Locate the mock-up where directed by the Program/Project Manager.
 - d. Examine installation within 1 hour of application to determine variances from the specified requirements due to shrinkage, temperature, and humidity.
 - 1) Where shrinkage and cracking are evident, adjust the mixture and method of application as necessary.
 - 2) Remove defective materials, and re-construct the mock-up using acceptable materials.
 - e. An accepted mock-up may remain a part of the Work.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver fireproofing material in the original unopened packages, fully identified as to manufacturer, brand, or other identifying data; date of manufacture; shelf life if applicable; and bearing the proper Underwriters Laboratories Inc. labels for Surface Burning Characteristic and Fire Resistance Classification.
- B. Storage and Handling Requirements:
 - 1. Store fireproofing material off the ground, under cover, and in a dry location until ready for use.
 - 2. Rotate the stock of fireproofing material, and use it prior to its expiration date.
 - a. Use materials having limited shelf life within the period indicated.
 - b. Discard materials whose shelf life has expired.
 - 3. Discard bags of fireproofing material exposed to water before use.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Do not apply spray fireproofing when the temperature of the substrate material and surrounding air is below 40 degrees Fahrenheit, unless temporary protection is provided to maintain the temperature at or above this level for 24 hours before, during, and for 24 hours after applying the spray fireproofing.
 - a. Submit information to the Program/Project Manager indicating the environmental conditions under which fireproofing materials were applied.
 - 2. In those areas where dry applied material is to be applied, ventilate the areas during the application of the fireproofing and for a minimum of 24 hours afterward until the fire-resistive material dries thoroughly.

1.08 WARRANTY

- A. Extended Correction Period:
 - 1. Warrant the fireproofing to remain free from cracking, checking, dusting, flaking, peeling, spalling, separation, blistering, delaminating, and eroding in excess of specified requirements within the 5-year period after the Date of Substantial Completion.
 - a. Submit the written Fireproofing Warranty on the manufacturer's standard form signed by the Contractor and Applicator to the Program/Project Manager for approval.



PART 2 PRODUCTS

2.01 FIREPROOFING ASSEMBLIES

- A. Manufacturers:
 - 1. Product Options:
 - a. Obtain the sprayed fire-resistive material (SFRM) through one source from one manufacturer.
- B. Regulatory Requirements:
 - 1. Provide fireproofing assemblies listed by Underwriters laboratories, Inc. (UL), Factory Mutual (FM), and/or Warnock Hersey (WH) as indicated and applicable.
- C. Sustainability Requirements:
 - 1. Recycled Content
 - a. Provide Fireproofing materials whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 20 percent.
- D. Design Criteria:
 - 1. Provide applied fireproofing assemblies as indicated on the Contract Drawings
 - a. Submit Provide Data for each product provided under this Section indicating the product's characteristics.
 - b. Submit special procedures required to deliver, handle, and/or apply the fireproofing.
 - 2. For exterior applications of sprayed fire-resistive material, provide formulations approved for surfaces exposed to the exterior.
- E. Performance:
 - 1. Provide UL fire-rated assemblies designed to provide the hourly ratings as follow:
 - a. Interior columns: 3 Hours.
 - b. Interior girders: 3 hours.
 - c. Interior floors: 2 hours.
 - d. Interior roof deck: 0 hours.
 - e. Exterior roof columns: 2 hours.
 - f. Column hangers: 3 hours.
 - g. Truss members: 3 hours.
 - h. Beam girders: 3 hours.
 - i. Floor beams not connected to columns: 2 hours.
 - j. Floor beams having a direct connection to columns: 2 hours.
- F. Sprayed Fire-Resistive Material (SFRM):



1. Provide a factory-mixed, dry, cement aggregate formulation or a chloride-free formulation of gypsum or Portland cement binders, additives, and inorganic aggregates mixed with water at the Site to form a slurry or mortar for conveyance and application.
2. Very Low Compressive Strength Fire-Resistive Material:
 - a. Provide factory mixed very low compressive strength fire-resistive material, consisting of mineral fibers, fillers, and inorganic binders.
 - b. Provide very low compressive strength fire-resistive material complying with the following requirements:
 - 1) Bond Strength: 200 pounds per square foot when set and dry and tested in accordance with the requirements of ASTM E 736.
 - 2) Bond Impact: No cracking, spalling, or delamination when tested in accordance with the requirements of ASTM E 760.
 - 3) Dry Density, Minimum: 11 pounds per cubic foot when tested in accordance with the requirements of ASTM E 605.
 - 4) Compressive Strength, Minimum: 3.5 psi when tested in accordance with the requirements of ASTM E 761.
 - 5) Surface Burning Characteristics:
 - a) Maximum flame spread: 0 when tested in accordance with the requirements of ASTM E 84.
 - b) Maximum smoke developed: 0 when tested in accordance with the requirements of ASTM E 84.
3. Low Density Sprayed Fire-Resistive Material:
 - a. Provide factory mixed low density sprayed fire-resistive material consisting of cementitious material blended with vermiculite or lightweight synthetic aggregate to produce a uniform texture.
 - b. Provide low density sprayed fire-resistive material complying with the following requirements:
 - 1) Bond Strength: 200 pounds per square foot when set and dry and tested in accordance with the requirements of ASTM E 736.
 - 2) Bond Impact: No cracking, flaking, or delamination when tested in accordance with the requirements of ASTM E 760.
 - 3) Dry Density, Minimum: 14 pounds per cubic foot minimum average density when tested in accordance with the requirements of ASTM E 605, with the minimum individual density of any test sample equaling 13 pounds per cubic foot.
 - 4) Compressive Strength, Minimum: 7.0 psi when tested in accordance with the requirements of ASTM E 761.
 - 1) Surface Burning Characteristics:
 - a) Maximum flame spread: 0 when tested in accordance with the requirements of ASTM E 84.
 - b) Maximum smoke developed: 0 when tested in accordance with the requirements of ASTM E 84.
4. Medium Density Sprayed Fire-Resistive Material:



- a. Provide factory mixed medium density sprayed fire-resistive material consisting of Portland cement blended with mineral aggregates or mineral fibers and additives without chlorides to produce a uniform texture.
 - b. Provide medium density sprayed fire-resistive material approved for exterior use.
 - c. Provide medium density sprayed fire-resistive material complying with the following requirements:
 - 1) Bond Strength: 2000 pounds per square foot when set and dry and tested in accordance with the requirements of ASTM E 736.
 - 2) Bond Impact: No cracking, flaking, or delamination when tested in accordance with the requirements of ASTM E 760.
 - 3) Dry Density, Minimum: 14 pounds per cubic foot minimum average density when tested in accordance with the requirements of ASTM E 605, with the minimum individual density of any test sample equaling 21 pounds per cubic foot.
 - 4) Compressive Strength, Minimum: 65 psi when tested in accordance with the requirements of ASTM E 761.
 - 5) Surface Burning Characteristics:
 - a) Maximum flame spread: 0 when tested in accordance with the requirements of ASTM E 84.
 - b) Maximum smoke developed: 0 when tested in accordance with the requirements of ASTM E 84.
5. High Density Sprayed Fire-Resistive Material:
- a. Provide factory mixed high density cementitious sprayed fire-resistive material consisting of Portland cement blended with mineral aggregates and additives without chlorides to produce a uniform texture.
 - b. Provide high density sprayed fire-resistive material approved for exterior use.
 - c. Provide high density sprayed fire-resistive material complying with the following requirements:
 - 1) Bond Strength: 2000 pounds per square foot when set and dry and tested in accordance with the requirements of ASTM E 736.
 - 2) Bond Impact: No cracking, flaking, or delamination when tested in accordance with the requirements of ASTM E 760.
 - 3) Dry Density, Minimum: 39 pounds per cubic foot minimum average density when tested in accordance with the requirements of ASTM E 605, with the minimum individual density of any test sample equaling 21 pounds per cubic foot.
 - 4) Compressive Strength, Minimum: 300 psi when tested in accordance with the requirements of ASTM E 761.
 - 5) Surface Burning Characteristics:
 - a) Maximum flame spread: 0 when tested in accordance with the requirements of ASTM E 84.



- b) Maximum smoke developed: 0 when tested in accordance with the requirements of ASTM E 84.

2.02 ACCESSORIES

A. Primer Adhesive:

- 1. Provide a type of primer adhesive recommended by the fireproofing manufacturer and approved by Underwriters laboratories, Inc. or another testing and inspection agency acceptable to the Authorities Having Jurisdiction.
 - a. Provide primer having a bond strength complying with the requirements specified in the UL Fire Resistance Directory (Fire Resistance Ratings) for coating materials based on a series of bond test performed in accordance with the requirements specified in ASTM E 736.
 - b. Provide primer identical to primer used in assemblies tested for fire-test-response characteristics of sprayed fire-resistive material in accordance with the requirements specified in ASTM E 119 by Underwriters laboratories, Inc. or another testing and inspection agency acceptable to the Authorities Having Jurisdiction.

B. Overcoat:

- 1. Provide an overcoat as recommended by the manufacturer of the fireproofing material.

C. Metal Lathe:

- 1. Provide expanded galvanized metal lathe.
- 2. Weight: 3.4 pounds per square foot.

D. Water:

- 1. Provide clean, potable water.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. Submit test reports from reputable independent testing agencies for tests conducted under conditions similar to those on this Contract for the products proposed for the Work of this Section, indicating compliance with the following special criteria:
 - a. Bond Strength Test:
 - 1) Test Procedure:
 - a) Determine the bond of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 736 and the UL Fire Resistance Directory (Fire Resistance Ratings).
 - 2) Acceptance Criteria:



- a) Bond strengths indicated in the referenced fire resistance design, but not less than the minimum value specified herein, are acceptable.
 - b) Verify that the material manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with the sprayed fire-resistive material.
- b. Bond Impact Test:
 - 1) Test Procedure:
 - a) Determine the effect of impact on the bonding of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 760.
 - 2) Acceptance Criteria:
 - a) Fireproofing evidencing no cracking, spalling, or delamination is acceptable.
- c. Dry Density Test:
 - 1) Test Procedure:
 - a) Determine the dry density of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 605.
 - 2) Acceptance Criteria:
 - a) Dry densities indicated in the referenced fire resistance design, but not less than the minimum value specified herein, are acceptable.
- d. Compressive Strength Test:
 - 1) Test Procedure:
 - a) Determine the compressive strength of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 761.
 - 2) Acceptance Criteria:
 - a) Compressive strengths indicated in the referenced fire resistance design, but not less than the minimum value specified herein, are acceptable.
- e. Fire-Test-Response Characteristic Test:
 - 1) Test Procedure:
 - a) Determine the fire-test-response characteristic of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 84 by Underwriters Laboratories, Inc. or another testing and inspection agency acceptable the Authorities Having Jurisdiction.
 - b) Identify bags containing sprayed fire-resistive materials with the appropriate markings of the applicable testing and inspection agency.
 - 2) Acceptance Criteria:
 - a) Sprayed fire-resistive materials having the fire-test-response characteristic specified are acceptable.



- f. Corrosion Resistance Test:
 - 1) Test Procedure:
 - a) Determine the corrosion resistance of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 937.
 - 2) Acceptance Criteria:
 - a) Fireproofing evidencing no corrosion is acceptable.
 - g. Deflection Test:
 - 1) Test Procedure:
 - a) Determine the deflection of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 759.
 - 2) Acceptance Criteria:
 - a) Fireproofing evidencing no cracking, spalling, or delamination is acceptable.
 - h. Air Erosion Test:
 - 1) Test Procedure:
 - a) Determine the air erosion of the sprayed fire-resistive material in accordance with the requirements specified in ASTM E 859.
 - 2) Acceptance Criteria:
 - a) Fireproofing having a maximum weight loss of 0.025 grams per square foot is acceptable.
 - i. Fungal Resistance Test:
 - 1) Test Procedure:
 - a) Determine fungal resistance of the sprayed fire-resistive material in accordance with the requirements specified in ASTM G 21.
 - 2) Acceptance Criteria:
 - a) Fireproofing evidencing no observed growth on specimens is acceptable.
- B. Coordination of Other Tests and Inspections:
- 1. Notify the code-required Approved Agency responsible for performing special inspections when fireproofing for this Contract is being placed and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
- 1. With the applicator present, verify the following at the Site:
 - a. The surfaces to receive fireproofing are ready and comply with the requirements specified for the substrate in other Sections.



- 1) Verify the substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt, and other foreign substances capable of impairing the bond of fire-resistive materials with substrates under conditions of normal use or fire exposure.
 - b. The clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place and securely attached to substrates.
 - c. The ducts, piping, equipment, or other items that would interfere with the application of fireproofing have not been installed.
 - d. The voids and cracks in the substrate have been filled.
 - e. Where fireproofing will be exposed to view as a finish material, the projections have been removed.
- B. Pre-Installation Testing:
1. For locations where adhesion of the fireproofing to the substrate is in question, perform tests as recommended by the fireproofing manufacturer to verify substrates are free of oil, rolling compounds, and other substances capable of interfering with the bond; and that proper adhesion will be achieved.
- C. Evaluation and Assessment:
1. Do not apply fireproofing until the non-conforming conditions that can interfere with applying the fireproofing have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect equipment and surfaces not scheduled to receive fireproofing from damage by overspray, fall-out, and dusting.
 2. Prevent spray fireproofing from contaminating the air by providing temporary enclosures.
 - a. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.
- B. Surface Preparation:
1. Prior to applying the fireproofing material, complete placing the concrete in the metal decking.
 2. Prepare substrates to receive the fireproofing in strict accordance with the instructions of the fireproofing manufacturer.
 - a. Clean substrates of substances that could impair the bond of fire-resistive material, including oil, grease, release agents, rolling compounds, incompatible paints, primers, encapsulants, loose mill scale, and dirt.



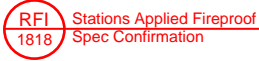
- b. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in the finished surface of the sprayed fire-resistive material.
 - 1) Remove minor projections and fill voids that would telegraph through the fire-resistive products after application.
 - c. Where recommended by the sprayed fire-resistive material manufacturer in writing, prime substrates unless compatible shop primer has been applied and is in satisfactory condition to receive the sprayed fire-resistive material.
 - 1) Apply primer adhesive in accordance with the primer adhesive manufacturer's instructions.
 - 2) Submit the primer adhesive application instructions from the fireproofing manufacturer to the Program/Project Manager for information.
 - d. Apply the fireproofing manufacturer's recommended bonding agent on primed steel.
 - 1) Submit the bonding agent application instructions from the fireproofing manufacturer to the Program/Project Manager for information.
 - 3. Close off and seal ductwork in areas where fireproofing will be applied.
- C. Demolition/Removal:
- 1. Remove incompatible materials that could affect the fireproofing material's bond by scraping, brushing, scrubbing, or sandblasting.

3.03 APPLICATION

- A. Install metal lathe over structural members as indicated on the Contract Drawings, or as required by the applicable UL Design Numbers for the assembly.
- B. Apply a sufficient thickness fireproofing to achieve the required ratings as specified, with as many passes as necessary produce a monolithic blanket cover having a uniform density and texture.
 - 1. Extend the full thickness of the fire-resistive material over the entire area of each substrate to be protected.
 - 2. Unless otherwise recommended by the sprayed fire-resistive material manufacturer in writing, apply the fire-resistive covering in a single course.
 - 3. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply sprayed fire-resistive material differing in color from the color of the encapsulant over which it is applied.
 - 4. Where sealers are used, apply products tinted to differentiate them from the sprayed fire-resistive material over which they are applied.
- C. Spray-apply the fire-resistive materials to the maximum extent possible.



1. Following the spraying operation, use tools and procedures recommended by the fireproofing manufacturer to complete the coverage of the substrates in exposed locations.



~~a. Trowel the fireproofing surface smooth and form square edges.~~

- D. Apply an overcoat sealer at a rate recommended by the fireproofing manufacturer.

3.04 REPAIR/RESTORATION

- A. As other construction operations proceed, inspect the sprayed fire-resistive material, and patch damaged or removed areas.
 1. Repair or replace sprayed fire-resistive material that has not been successfully protected.
- B. Repair defective applied fireproofing discovered within the extended warranty period, or replace it with new acceptable fireproofing.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when fireproofing is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Inspections:
 - a. After the fireproofing has been applied and cured but before concealing it, test and inspect the integrity of the fireproofing.
 - 1) Tested values must equal or exceed the values indicated and required for the approved fire-resistance design.
 - 2) Do not apply sprayed fire-resistive material for successive areas until the material of the preceding completed area has been shown to comply with the specified requirements.



- b. Verify that the actual thicknesses, densities, and bond strengths comply with the ratings specified.
 - c. If Work that may affect or disrupt the integrity of the fire protection provided by the applied fireproofing is performed after the fireproofing is applied, re-inspect the applied fireproofing to verify that its integrity remains intact.
- B. Non-Conforming Work
 - 1. If testing indicates that applications of the sprayed fire-resistive material are not in compliance with the specified requirements, additional random testing will be conducted to determine the extent of non-conformance.
 - 2. Remove and replace sprayed fire-resistive material not conforming to the requirements for cohesion and adhesion, for density, or for both.
 - 3. Where test results indicate the thickness does not comply with required thicknesses, apply additional sprayed fire-resistive material in accordance with the manufacturer's written instructions.
 - 4. The replaced or additional sprayed fire-resistive material will be tested for compliance with the specified requirements.

3.06 CLEANING

- A. Immediately after completing spraying operations in each containable area, remove excess fireproofing material, overspray, fallout, droppings, and debris.
 - 1. Clean exposed areas to remove evidence of soiling.
- B. Remove fireproofing from materials and surfaces not required to be fireproofed.
- C. At exposed fireproofing, clean surfaces that have become soiled or stained, using the fireproofing manufacturer's recommended procedures.

3.07 PROTECTION

- A. During the installation of fireproofing on roofs and during its drying period, do not allow foot traffic in that area of the roof.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All.	First Edition



SECTION 07842

FIRE-RESISTIVE JOINT SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for perimeter fire-resistive joint systems consisting of floor-to-wall joints between the perimeter edge of fire-resistance-rated floor assemblies and exterior curtain walls.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 05810 - Expansion Joint Cover Assemblies.
 - 5. Section 07850 - Through Penetration Firestopping Systems.
 - 6. Section 07920 - Joint Sealants.

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. L-Rating: The L-Rating is a UL-rating that measures the amount of air that moves through an opening in cubic feet per minute per square foot of opening area, at ambient temperatures and 400 degrees Fahrenheit.
 - a. The 2 temperature levels simulate cold and hot smoke moving in a building.
 - 3. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.



3. FM Approvals LLC (FM):
 - a. FM Class Number 4991 – Approval Standard for Approval of Firestop Contractors.
 - b. The Approval Guide, www.approvalguide.com.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. ICC Evaluation Service, Inc. (ICC ES), <http://www.icc-es.org/reports/index>:
 - a. ICC-ES AC30 – Acceptable Criteria for Fire-Resistant Joint Systems.
 - b. ICC-ES ER-4976 – Legacy Report: SpecSeal Fire Stop Penetration Systems.
6. Underwriters Laboratories, Inc. (UL):
 - a. UL 2079 –Standard for Tests for Fire Resistance of Building Joint Systems.
 - b. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.
 - c. UL's "Fire Resistance Directory"
7. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. To ensure that the fire-resistive joint systems are installed in accordance with the specified requirements, coordinate the construction of joints.
 2. Coordinate the sizing of joints to accommodate the fire-resistive joint systems.
 3. Notify the Owner's inspecting agency at least 7 days in advance of the fire-resistive joint system installations.
 - a. Confirm the dates and times on days preceding each series of installations.
- B. Sequencing:
 1. Do not cover up the fire-resistive joint system installations that will become concealed behind other construction until the Owner's inspecting agency and the building inspector of the Authorities Having Jurisdiction have examined each installation.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Joints in or between fire-resistance-rated constructions.



- 2) Joints at the intersection of fire-resistance-rated floor or floor/ceiling assembly and an exterior curtain-wall assembly.
 - 3) Perimeter fire-resistive joint systems.
 - b. Shop Drawings:
 - 1) Fire-resistive joint system.
 - c. Certificates:
 - 1) Manufacturer's Certificate of Compliance for each type of fire-resistive joint system.
 - d. Special Procedure Submittals:
 - 1) Evidence of each fire-resistive joint system's compliance with the acceptance criteria specified in ICC-ES AC30.
 - e. Qualification Statements:
 - 1) Fire-resistive joint system installer's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Evaluation Reports from the ICC Evaluation Service, Inc. (ICC ES) for each type of fire-resistive joint system.
 - b. Manufacturer's Instructions:
 - 1) Fire-resistive joint system manufacturer's written cleaning instructions.
 - 2) Fire-resistive joint system manufacturer's recommended priming products and methods.
 - 3) Fire-resistive joint system manufacturer's written installation instructions.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Fire-Resistive Joint System Installer's Qualifications:
 - a. Employ a firm that has been approved by FM Global in accordance with the requirements specified in FM Class Number 4991.
 - b. Assign the responsibility for installation of both the through-penetration firestopping systems specified in Section and fire-resistive joint systems provided under this Section 07850, Through Penetration Firestopping Systems, for this Contract to a single qualified installer.
 - c. Submit the fire-resistive joint system installer's qualifications to the Program/Project Manager for approval.



B. Certifications:

1. Fire-Resistive Joint System Manufacturer's Certificates of Compliance:

- a. Submit a manufacturer's Certificate of Compliance, signed by the fire-resistive joint system manufacturer, for each type of fire-resistive joint system provided for the Work of this Section certifying that the products comply with the specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver fire-resistive joint system products to the Site in their original, unopened containers or packages marked with a qualified testing and inspecting agency's classification marking applicable to the Contract, and having intact and legible manufacturers' labels identifying the product and manufacturer, the date of manufacture, the lot number, the shelf life, the curing time, and the mixing instructions for multi-component materials.

B. Storage and Handling Requirements:

1. Store and handle materials for the fire-resistive joint systems so deterioration or damage due to moisture, temperature changes, contaminants, or other causes is prevented.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not install the fire-resistive joint systems when the ambient or substrate temperatures are outside the limits permitted by the fire-resistive joint system manufacturers, or when the substrates are wet due to rain, frost, condensation, or other causes.
2. Ventilate the fire-resistive joint systems in accordance with the manufacturer's written instructions by natural means; or if this is inadequate, using forced-air circulation.

PART 2 PRODUCTS

2.01 FIRE-RESISTIVE JOINT SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.

2. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Only provide components specified by the fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for the systems provided.
 - c. Source Limitations:
 - 1) For each kind of joint and construction condition indicated in the Contract Documents, obtain fire-resistive joint systems from one source and from a single manufacturer.
- B. Description:
- 1. Provide fire-resistive joint systems that resist the spread of fire in accordance with the requirements specified, resist the passage of smoke and other gases, and maintain the original fire-resistance rating of the assembly in which the fire-resistive joint systems are installed.
 - 2. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 3. Sustainability Requirements:
 - a. All fire-resistive joint system sealant and primers shall comply with the following limits for VOC content when calculated according to 40 CFR 50, Subpart D (EPA Method 24).
 - 1) Architectural Sealants: 250 g/L
 - 2) Sealant Primers for Nonporous Substrates: 250g/L
 - 3) Sealant Primers for Porous Substrates: 775g/L.
- C. Performance:
- 1. Joint Systems in and between Fire-Resistance-Rated Constructions:
 - a. Provide systems having assembly fire-resistance ratings equaling or exceeding the ratings of the construction that they join as determined in accordance with the methods specified in UL 2079.
 - 1) Determine the load-bearing capabilities of the assembly by evaluation during the time of the test.
 - 2. Perimeter Fire-Resistive Joint Systems:
 - a. For joints between the edges of fire-resistance-rated floor assemblies and exterior curtain walls, provide systems of the type and having the ratings indicated in the Contract Documents as determined in accordance with the methods specified in UL 2079.
 - b. UL-Listed, Perimeter Fire-Containment Systems:
 - 1) Provide integrity ratings equaling or exceeding the fire-resistance ratings of the floor or floor/ceiling assembly forming one side of the joint.
 - 3. Fire-Test-Response Characteristics:



- a. Qualified testing and inspecting agencies acceptable to the Authorities Having Jurisdiction, such as Underwriters Laboratories, Inc. (UL), perform qualification testing and follow-up inspections of fire-resistive joint systems.
 - 1) The fire-resistive joint systems to be provided under this Section must be identical to those tested by the qualified testing and inspecting agencies during qualification testing.
 - 2) Provide fire-resistive joint system products that bear the classification marking of the qualified testing and inspecting agency.
 - 3) Provide fire-resistive joint systems that correspond to those indicated by the referencing system designations of the qualified testing and inspecting agency specified for the Work of this Contract.
 - b. Surface-Burning Characteristics:
 - 1) Provide fire-resistive joint systems complying with the following surface-burning characteristic requirements when tested in accordance with the method specified in ASTM E 84:
 - a) Flame Spread Index: 25 or less.
 - b) Smoke-Developed Index: 450 or less.
 - 2) Identify the surface-burning characteristics of the ceiling components using the appropriate markings of the applicable testing and inspecting organization.
- D. Design Criteria:
- 1. Provide fire-resistive joint systems designed to meet the acceptance criteria specified in ICC-ES AC30.
 - a. Submit evidence of each fire-resistive joint system's compliance with the acceptance criteria specified in ICC-ES AC30 to the Program/Project Manager for approval.
 - 2. Provide fire-resistive joint systems that are compatible with the joint substrates under the conditions of service and application as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.
 - 3. Product Data:
 - a. Obtain the fire-resistive joint system manufactures' Product Data for each type of product proposed for the Work of this Section.
 - b. Obtain Evaluation Reports from the ICC Evaluation Service, Inc. (ICC ES) for each type of fire-resistive joint system.
 - c. Submit the fire-resistive joint system manufactures' Product Data and the Evaluation Reports from the ICC Evaluation Service, Inc. (ICC ES) for each type of fire-resistive joint system to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings for each fire-resistive joint system showing each kind of construction condition in which the joints will be installed.



- 1) Show the relationships to adjoining construction.
 - 2) Include the fire-resistive joint system design designation of the testing and inspecting agency acceptable to the Authorities Having Jurisdiction that demonstrates compliance with requirements for each condition indicated.
 - 3) Include documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.
 - b. Submit the Shop Drawings for each fire-resistive joint system to the Program/Project Manager for approval.
- E. Materials:
 1. Joints in or between Fire-Resistance-Rated Constructions:
 - a. For joints in or between fire-resistance-rated constructions, provide fire-resistive joint systems complying with the requirements specified for Category Code XHBN as listed in UL's "Fire Resistance Directory".
 - 1) Hilti Corporation, FS 657 Fire Block, <http://www.hilti.com>.
 - 2) Approved equal.
 2. Joints at the Intersection of Fire-Resistance-Rated Floor or Floor/Ceiling Assembly and an Exterior Curtain-Wall Assembly:
 - a. For joints at the intersection of fire-resistance-rated floor or floor/ceiling assembly and an exterior curtain-wall assembly, provide fire-resistive joint systems complying with the requirements specified for Category Code XHDB as listed in UL's "Fire Resistance Directory".
 3. Perimeter Fire-Resistive Joint Systems:
 - a. For perimeter fire-resistive joint systems, provide fire-resistive joint systems complying with the following requirements:
 - 1) Integrity Rating: 2 hours.
 - 2) Insulation Rating: 1/4 hour.
 - 3) Linear Opening Width: No more than indicated on the Contract Drawings.
 - 4) L-Rating at Ambient Temperature: Less than 1 cubic foot per minute per linear foot.
 - b. Manufacturers:
 - 1) Specified Technologies Inc., Basis of Design Product: Design No. CW-S-1011, <http://www.stifirestop.com>.
 - 2) Approved equal.

2.02 ACCESSORIES

- A. Provide the components of fire-resistive joint systems, including primers and forming materials, that are needed to install the fill materials and to comply with the specified performance requirements.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine substrates and conditions where fire-resistive joint systems will be installed for compliance with requirements for joint configurations, substrates, and other conditions affecting performance.
- B. Evaluation and Assessment:
 - 1. Proceed to install fire-resistive joint systems only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the fire-resistive joint systems.
 - a. Masking Tape:
 - 1) Provide masking tape to prevent fill materials of the fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials.
 - 2) Remove the masking tape as soon as possible without disturbing the fire-resistive joint system's seal with the substrates or damaging adjoining surfaces.
- B. Surface Preparation:
 - 1. Surface Cleaning:
 - a. Clean joints immediately before the installing fire-resistive joint systems in accordance with the fire-resistive joint system manufacturer's cleaning instructions and the following requirements:
 - 1) Remove foreign materials that could interfere with adhesion of fill materials from the surfaces of joint substrates.
 - 2) Clean joint substrates to produce clean, sound surfaces capable of developing the optimum bond with fill materials.
 - a) Remove loose particles remaining from the cleaning operation.
 - 3) Remove laitance and form-release agents from concrete.
 - b. Submit the fire-resistive joint system manufacturer's written cleaning instructions to the Program/Project Manager for information.
 - 2. Priming:



- a. Where recommended in writing by the fire-resistive joint system manufacturer, prime the substrates using that manufacturer's recommended products and methods.
 - 1) Submit the fire-resistive joint system manufacturer's recommended priming products and methods to the Program/Project Manager for information.
 - b. Confine primers to the areas of bond.
 - 1) Do not allow spillage and migration of the primers onto exposed surfaces.
- C. Demolition/Removal:
- 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install the fire-resistive joint systems so they comply with the specified performance requirements and the fire-resistive joint system manufacturer's installation instructions for the products and applications indicated in the Contract Documents.
 - 1. Submit the fire-resistive joint system manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Forming, Packing, and Backing Materials:
 - 1. Install forming, packing, backing materials, and other accessories of the types required to support the fire-resistive joint system fill materials during their application; and in the position needed to produce the cross-sectional shapes and depths required to achieve the fire ratings indicated in the Contract Documents.
- C. Fill Materials:
 - 1. Install the fill materials for fire-resistive joint systems using proven techniques.
 - a. Fill voids and cavities formed by openings and forming, packing, and backing materials as required for achieving the fire-resistance ratings indicated in the Contract Documents.
 - b. Apply fill materials so they contact and adhere to the substrates formed by the joints.
 - c. Finish the fill materials that will remain exposed after the Work is completed so the finish is a smooth, uniform surface, flush with the adjoining finishes.
- D. Special Techniques:
 - 1. For fire-resistive joint systems consisting of metal frames and covers, comply with the requirements specified in Section 05810, Expansion Joint Cover Assemblies.



2. For systems installed in openings in walls and floors with and without penetrating items, comply with the requirements specified in Section 07850, Through Penetration Firestopping Systems.
3. For non-fire-resistive joint sealants, comply with the requirements specified in Section 07920, Joint Sealants.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Inspecting Agency:
 - a. The Owner will engage a qualified independent inspecting agency to inspect the fire-resistive joint systems and to prepare inspection reports.
2. Inspections:
 - a. Inspections of completed fire-resistive joint system installations will take place in successive stages as the installation proceeds.
 - b. Do not proceed to install joint systems for the next area until the inspecting agency determines that the completed Work is in compliance with the specified requirements.
 - c. The inspecting agency will state in each report whether the inspected fire-resistive joint systems comply with or deviate from the specified requirements.
 - d. Proceed to enclose the fire-resistive joint systems with other construction only after the inspection reports are issued, and the fire-resistive joint systems have been determined to comply with the specified requirements.

B. Non-Conforming Work

1. Where the inspections indicate that the fire-resistive joint systems do not comply with the specified requirements, remove the non-conforming Work and replace it with acceptable replacement materials.
2. Additional inspections to determine the compliance of replaced or additional work with the specified requirements will be performed at the Contractor's expense.

3.05 CLEANING

- A. Clean off excess fill materials adjacent to joints as the Work progresses using methods and cleaning materials that are approved in writing by the fire-resistive joint system manufacturers, and that do not damage the materials in which the openings occur.
- B. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.06 PROTECTION

- A. Provide final protection, and maintain conditions, during and after installation that ensure the fire-resistive joint systems have not been damaged and have not deteriorated at the time of Substantial Completion.
1. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately, and install new materials to produce fire-resistive joint systems complying with the specified requirements.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.3, 1.02.C.7, 1.04.B.2, 2.01.B.3	Add requirements for ENVISION Sustainability Rating System





SECTION 07850

THROUGH PENETRATION FIRESTOPPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for through penetration firestopping systems, including the following:
 - a. Through penetration firestopping in fire rated construction.
 - b. Construction-gap firestopping at connections of the same or different materials in fire-rated construction.
 - c. Construction-gap firestopping occurring within fire-rated wall, floor, or floor/ceiling assemblies.
 - d. Construction-gap firestopping occurring at the top of fire-rated walls.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 07210 – Building Insulation.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Assembly: A particular arrangement of materials specific to a given type of construction described or detailed in the referenced documents.
 - 2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.



3. Barriers: Time rated fire walls, smoke barrier walls, and time rated ceiling/floor assemblies and structural floors.
4. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses, and smoke.
5. Penetration: An opening for foreign material passing through or into a barrier or structural floor such that full thickness of rated materials is not obtained.
6. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
7. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. or another qualified testing and inspection agency to close specific barrier penetrations.
8. Sleeve: A metal fabrication or pipe section extending through the thickness of a barrier, used to permanently guard the penetration. Sleeves are described as part of the penetrating system in other Sections, and may or may not be required at penetrations.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.
 - b. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - c. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - d. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - e. ASTM E 1399 - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. Intertek Group plc:
 - a. Intertek Directory of Listed Product Search,
<http://etlwhidirectory.etlsemko.com>
 - 1) Warnock Hersey Mark Directory.
5. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
6. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - b. UL 1479 – Standard for Fire Tests of Through-Penetration Firestops.



7. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - 2) 40 CFR 763 - Asbestos.
 - b. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Notify the Program/Project Manager at least 7 days in advance of through-penetration firestop system installations.
 - b. Confirm the dates and times on the days preceding each series of installations.
 2. Coordinating Work:
 - a. Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.
- B. Sequencing:
 1. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until the Testing and Inspection Agency, the Approved Agency, and the City building inspector have examined each installation.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Fill Materials.
 - 2) Fire-Resistive Joint Sealants.
 - 3) Fill, Void, or Cavity Materials.
 - 4) Forming Materials.
 - 5) Manufacturer's full range of standard joint sealant colors.
 - b. Shop Drawings:



- 1) Through-penetration firestop systems.
 - c. Certificates:
 - 1) Through-Penetration Firestop System Manufacturer's Certification.
 - d. Qualification Statements:
 - 1) Installer Qualification from the Manufacturer.
 - 2) Installer's Experience.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Product test reports from a qualified testing agency.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's written instructions for ventilation during installation of their through-penetration firestop systems.
 - 2) Manufacturer's written recommendations regarding priming.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Installer's Qualifications:



- a. Employ an experienced installer who is qualified by having the necessary experience, staff, and training to install the manufacturer's products in accordance with the specified requirements.
 - 1) A manufacturer's willingness to sell its through-penetration firestop system products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer.
 - 2) Installer Qualification from the Manufacturer:
 - a) Prior to installing fire stop assemblies, have the installer submit written proof of his qualification from the manufacturer of the fire stop material, certifying that the installer has satisfactorily completed technical and installation training for the specified products, to the Program/Project Manager for approval.
 - 3) Installer's Experience:
 - a) Submit the installer's experience to the Program/Project Manager for approval.
 - (1) Include lists of completed projects with the project names and addresses, and the names and addresses of architects and owners.
- C. Certifications:
 - 1. Through-Penetration Firestop System Manufacturer's Certification:
 - a. Submit a Manufacturer's Certification signed by the through-penetration firestop system manufacturer certifying that the products provided for the Work of this Section comply with the specified requirements.
 - 1) Include certification from the manufacturer that the products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver through-penetration firestop system products to the Site in their original, unopened containers or packages with intact and legible manufacturers' labels identifying the product and manufacturer, date of manufacture, lot number, shelf life if applicable, applicable qualified testing and inspecting agency's classification marking, curing time, and for multi-component materials mixing instructions.
- B. Storage and Handling Requirements:
 - 1. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.



1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers, or when substrates are wet due to rain, frost, condensation, or other causes.
2. Ventilate through-penetration firestop systems in accordance with the manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.
 - a. Submit the manufacturer's written instructions for ventilation during installation of their through-penetration firestop systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer List:

1. Fill Material Manufacturers:
 - a. Non-Mortar Systems:
 - 1) Obtain products from manufacturers whose products for the applicable system, as shown on the Contract Drawings, are listed in UL's Fire Resistance Directory.
 - b. Mortar Systems:
 - 1) Obtain products from manufacturers whose products for the applicable system, as shown on the Contract Drawings, are approved by Warnock Hersey
2. Fire-Resistive Elastomeric Joint Sealant Manufacturers:
 - a. Obtain products from manufacturers whose products for the applicable system, as shown on the Contract Drawings, are listed in UL's Fire Resistance Directory.

B. Substitution Limitations:

1. Information on the Contract Drawings referring to specific design designations of through-penetration firestop systems is intended to establish the performance requirements based on the conditions that are expected to exist during installation.
2. Any changes in conditions and designated systems require the Program/Project Manager's prior approval.
3. Submit documentation showing that the performance of proposed substitutions equals or exceeds that of the systems they would replace and are acceptable to the Authorities Having Jurisdiction.

C. Product Options:

1. All firestopping products must be from a single manufacturer.



- a. For each different kind of penetration and construction condition required, obtain the through-penetration firestop systems from a single manufacturer.
- b. All trades must use products from the same manufacturer.
2. Submit Product Data for each type of product proposed for the through-penetration firestop systems to the Program/Project Manager for approval.

2.02 DESCRIPTION:

A. Regulatory Requirements:

1. Fire-Test-Response Characteristics:
 - a. Qualified testing and inspecting agencies acceptable to the Authorities Having Jurisdiction, such as Underwriters Laboratories, Inc. (UL) and Warnock Hersey, perform testing and follow-up inspections of firestopping systems.
 - 1) The through-penetration firestopping systems are tested in accordance with the requirements specified in ASTM E 814 under conditions where a positive furnace pressure differential of at least 0.01 inch of water is maintained at a distance of 0.78 inch below the fill materials surrounding the penetrating items in the test assembly.
 - 2) The fire-resistive joint sealant systems are tested for fire-response characteristics in accordance with the requirements specified in ASTM E 119 under conditions where the positive furnace pressure differential is at least 0.01 inch of water, as measured 0.78 inch from the face exposed to the furnace fire.
 - 3) Underwriters Laboratories, Inc. (UL) Fire Resistance Directory:
 - a) Underwriters Laboratories, Inc. publishes a Fire Resistance Directory which lists all assemblies, systems, and devices UL has tested, and classifies them under Category Codes (CCN) in the UL Online Certifications Directory, including the following applicable to the Work of this Section:
 - (1) Through-Penetration Firestop Devices (XHCR).
 - (2) Fire Resistance Ratings – ANSI/UL 263 (BXUV).
 - (3) Through-Penetration Firestop Systems (XHEZ).
 - (4) Fill, Void or Cavity Material (XHHW).
 - (5) Forming Materials (XHKU).
 - b. The through-penetration firestopping systems and fire-resistive joint sealant systems tested are identical to those to be provided under this Section.
 - 1) Provide fireproofing assemblies listed by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Warnock Hersey (WH) as applicable.
 - 2) Provide sealants having the fire-resistance ratings indicated in the applicable Design/System/Construction/Assembly listed in the UL



- Fire Resistance Directory, or by another qualified testing and inspecting agency.
- 3) Provide joint sealants, including their backing materials that bear the classification marking of the qualified testing and inspecting agency.
- c. Product Test Reports:
 - 1) Submit product test reports from a qualified testing agency indicating the through-penetration firestop systems comply with the specified requirements based on comprehensive testing of current products.
- 2. Asbestos:
 - a. Provide firestopping products containing no detectable asbestos as determined by the Polarized Light Microscopy Method specified in Subpart E, Appendix E, Section 1 of 40 CFR 763.
- 3. Volatile Organic Compounds (VOC) Content of Fire-Resistive Joint Sealants:
 - a. Provide sealants and sealant primers for the firestopping system of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - 1) Sustainable Goal: VOC Limit for Fire-Resistive Joint Sealants: 250 grams per Liter.
- B. Sustainability Requirements:
 - 1. All firestopping sealant shall comply with the following limits for VOC content when calculated according to 40 CFR 50, Subpart D (EPA Method 24).
 - a. Architectural Sealants: 250 g/L

2.03 PERFORMANCE:

- A. Flame-Spread and Smoke-Developed Ratings:
 - 1. For through-penetration firestop systems exposed to view, provide products having flame-spread ratings of less than 25, and smoke-developed ratings of less than 450, as determined in accordance with the requirements specified in ASTM E 84.
 - a. For communications pathways, provide products having smoke development ratings of less than 50.
- B. Fire-Resistive Joint Sealants:
 - 1. Provide joint sealants with the fire-resistance ratings indicated on the Contract Drawings as determined in accordance with the requirements specified in ASTM E 119, but not less than the fire-resistance rating of the construction in which the joint occurs.



C. Durability:

1. Provide through-penetration firestop systems that during and after construction do not deteriorate when exposed to view, traffic, moisture, and/or physical damage after curing.

2.04 DESIGN CRITERIA:

A. Provide firestopping systems designed to resist the spread of fire and the passage of smoke and other gases according to the specified requirements.

1. Provide firestopping systems composed of the materials specified for the application and that comply with the system performance and other requirements.

B. F-Rated Systems:

1. Provide through-penetration firestop systems with the F-ratings indicated on the Contract Drawings, as determined in accordance with the requirements specified in ASTM E 814, but not less than that equaling or exceeding the fire-resistance rating of the constructions penetrated.

C. T-Rated Systems:

1. Where firestopping systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas, provide through-penetration firestop systems with both the T-ratings and the F-ratings indicated on the Contract Drawings, as determined in accordance with the requirements specified in ASTM E 814.

D. Product Compatibility:

1. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with items penetrating the through-penetration firestop systems, under the conditions of service and application indicated based on the testing and field experience of the through-penetration firestop system manufacturer.

E. Shop Drawings:

1. For each through-penetration firestop system, submit Shop Drawings showing each kind of construction condition penetrated, relationships to adjoining construction, and the kind of penetrating item.
 - a. Include the firestop design designation of the testing and inspecting agency acceptable to Authorities Having Jurisdiction that evidences compliance with the requirements for each condition indicated.
 - b. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.

2.05 MATERIALS

A. Fill Materials:



1. Provide systems or devices that are classified by UL under Category Codes (CCN) XHEZ in the UL Online Certifications Directory or XHCR in the UL Fire Resistance Directory, provided that the system or device conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance.
 - a. For wall applications, provide symmetrical systems.
 - b. Provide asbestos-free systems or devices.
 - c. Mortar systems must be approved by Warnock Hersey.
2. Provide systems or devices capable of withstanding the passage of cold smoke, either as an inherent property of the system or by using a separate product included as a part of the UL system or device designed to perform this function.

B. Fire-Resistive Joint Sealants:

1. Provide the manufacturer's standard chemically curing, fire-resistive elastomeric joint sealants manufactured from the base polymer indicated; and complying with the requirements specified for the Type, Grade, Class, and Uses in ASTM C 920 and the requirements specified in this Section applicable to fire-resistive joint sealants.
 - a. Single-Component, Neutral-Curing Silicone Sealant:
 - 1) Provide Type S; Grade NS; Class 25; exposure-related Use NT and joint substrate-related Uses M, G, A, and if applicable to the joint substrates shown O.
 - b. Multi-Component; Nonsag, Urethane Sealant:
 - 1) Provide Type M; Grade NS; Class 25; exposure-related Use NT, and joint substrate-related Uses M, A, and if applicable to the joint substrates indicated O.
 - c. Single-Component, Nonsag, Urethane Sealant:
 - 1) Provide Type S; Grade NS; Class 25; and Uses NT, M, A, and joint substrate-related Uses M, G, A, and if applicable to the joint substrates indicated O.
2. Colors:
 - a. Provide fire-resistive joint sealants having the colors selected by the Program/Project Manager from the manufacturer's full range of standard colors for products of the type provided.
 - 1) Submit the manufacturer's full range of standard joint sealant colors to the Program/Project Manager for information.
 - b. Where fire-resistive joint sealants are exposed to view, match the color of the adjacent surface.

2.06 ACCESSORIES

- A. Provide the components for each through-penetration firestop system needed to install the fill materials and to comply with the specified performance requirements.



1. Provide only the components specified by the through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for the applicable firestop systems.
- B. Fill, Void, or Cavity Materials:
 1. Provide fill, void, or cavity materials that are classified by UL under Category Code (CCN) XHHW in the UL Online Certifications Directory.
- C. Forming Materials:
 1. Provide forming materials that are classified by UL under Category Code (CCN) XHKU in the UL Online Certifications Directory.
- D. Safing Insulation:
 1. Provide safing insulation and accessories as specified in Section 07210, Building Insulation.

2.07 SOURCE QUALITY CONTROL

- A. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when firestopping for this Contract is being mixed, placed, and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the installer present, examine the substrates and existing conditions for compliance with the requirements for the opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Evaluation and Assessment:
 1. Install through-penetration firestop systems only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Apply masking tape to adjoining surfaces that will remain exposed on completion of the through-penetration firestop systems that would otherwise be permanently stained or damaged by contact with the firestop systems' materials.



2. Apply masking tape to adjoining surfaces that would otherwise be permanently stained or damaged by cleaning methods used to remove smears from the firestop system materials.

B. Surface Preparation:

1. Cleaning:

- a. Immediately before installing through-penetration firestop systems, clean out the openings to comply with the written recommendations of the firestop system manufacturer.
- b. Remove foreign materials that could interfere with the adhesion of the through-penetration firestop systems from the surfaces of the opening substrates and penetrating items.
- c. Clean the surfaces of the opening substrates and penetrating items so clean, sound surfaces capable of developing the optimum bond with the through-penetration firestop systems result.
- d. Remove loose particles remaining from the cleaning operation.
- e. Remove laitance and form-release agents from concrete.

2. Priming:

- a. If the through-penetration firestop system manufacturer recommends priming the substrate, use the manufacturer's recommended products and methods to prime the substrate.
- b. Confine primer to the area of the bond, and do not allow spillage and migration of primer onto exposed surfaces.
- c. Submit the manufacturer's written recommendations regarding priming to the Program/Project Manager for information.

3.03 INSTALLATION

A. Mixing:

1. For those products requiring mixing before application, comply with the through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water if required, the type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for the application indicated on the Contract Drawings.

B. Installing Through Penetration Firestop Systems:

1. Install through-penetration firestop system products for the applications indicated on the Contract Drawings in accordance with the firestop system manufacturer's written installation instructions and published drawings.
2. Forming/Damming/Backing Materials:
 - a. Install forming/damming/backing materials and other accessories of the types required to support the fill materials during their application, and in the position needed to produce cross-sectional shapes and



depths required to achieve the fire ratings indicated on the Contract Drawings.

3. Fill Materials:

- a. Install fill materials for firestop systems using proven techniques to produce the following results:
 - 1) Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items required to achieve the fire-resistance ratings indicated on the Contract Drawings.
 - 2) Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3) Finish fill materials that will remain exposed after completion of the Work to produce smooth, uniform surfaces that are flush with adjoining finishes.

C. Installing Fire-Resistive Joint Sealants:

1. Joint Fillers:

- a. Install joint fillers so the cross-sectional shapes and depths will allow optimum movement of the sealants subsequently installed and supported by the fillers, and so the fire-resistance rating required relative to the joint widths will be developed.

2. Sealants:

- a. Using proven techniques, apply sealants so they directly contact and fully wet joint substrates, completely fill the recesses provided for each joint configuration, and provide uniform, cross-sectional shapes and depths that allow optimum sealant movement relative to the joint widths.
 - 1) Apply sealants at the same time joint fillers are installed.
 - 2) Tool non-sag sealants immediately after applying the sealant, but prior to the time skinning or curing begins.
 - a) Do not use tooling agents that discolor the sealants or adjacent surfaces, or are not approved by sealant manufacturer.
 - 3) Form smooth, uniform sealant beads configured as indicated on the Contract Drawings, or as required to produce the specified fire-resistance rating, and to eliminate air pockets.
 - a) Ensure that the sealants contact and adhere to the sides of joint.
- b. Remove excess sealant from surfaces adjacent to joint.

3.04 REPAIR/RESTORATION

- A. If damage or deterioration to the through-penetration firestop system occurs, cut out and remove damaged or deteriorated elements immediately, and install new materials to produce through-penetration firestop systems complying with the specified requirements.



3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when firestopping is being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Inspections:
 - a. The Testing and Inspection Agency and code-required Approved Agency will prepare test reports stating whether inspected through-penetration firestop systems comply with or deviate from the specified requirements.
- B. Non-Conforming Work
 - 1. Where deficiencies are found in the through penetration firestop systems, repair or replace the systems so they comply with the specified requirements.
- C. Manufacturer Services:
 - 1. Have the manufacturer of the fire stop material perform sufficient inspections of the installed systems to assure that the acceptance criteria required by the Contract, the Code, and the minimum standards shown in each UL system installed are met.
 - a. These inspection requirements are in addition to any requirement and/or field inspection requirements requested by the local Authority Having Jurisdiction.

3.06 CLEANING

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by the through-penetration firestop system manufacturers, and that do not damage the materials in which the openings occur.



1. Remove masking tape used to protect surfaces adjoining through-penetration firestop systems as soon as possible after installing the firestop systems without disturbing the firestop systems' seals with the substrates.

3.07 PROTECTION

- A. During construction, provide protection and maintain the conditions that ensure that through-penetration firestop system Work is without damage or deterioration at the time of Substantial Completion.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 07920

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for joint sealants
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01400 - Quality Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 07844 - Fire-Resistant Joint Sealants.
 - 6. Section 08800 - Glazing.
 - 7. Section 09260 - Gypsum Board Assemblies.
 - 8. Section 09310 - Ceramic Tile.
 - 9. Section 09525 - Acoustical Panel Ceiling.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM C 834 - Standard Specification for Latex Sealants.
 - b. ASTM C 919 - Standard Practice for Use of Sealants in Acoustical Applications.
 - c. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.



- d. ASTM C 1021 - Standard Practice for Laboratories Engaged in the Testing of Building Sealants.
- e. ASTM C 1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
- f. ASTM C 1193 - Standard Guide for Use of Joint Sealants.
- g. ASTM C 1248 – Standard Test Method for Staining Products of Porous Substrate by Joint Sealants.
- h. ASTM C 1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
- i. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- j. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound transmission Loss of Building Partitions and Elements.
- k. ASTM E 548 – Standard Guide for General Criteria Used for Evaluating Laboratory Competence.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 4. Sealant Waterproofing and Restoration Institute (SWR Institute):
 - a. SWR Institute Liquid Sealant Validation Program.
- 5. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 6. United States Government:
 - a. Food and Drug Administration (FDA):
 - 1) 21 CFR 177 – Indirect Food Additives: Polymers.
 - b. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 7. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meetings:
 - 1. Pre-installation Conference:
 - a. Conduct a pre-installation conference at the Site in accordance with the requirements specified in Section 01316, Project Meetings.
- B. Sequencing:
 - 1. Unless otherwise indicated, sequence joint sealant installation to occur not less than 21 or more than 30 days after completion of waterproofing.



C. Scheduling:

1. Allow sufficient time to perform the Preconstruction Compatibility and Adhesion Testing specified in Subparagraph 1.05.D.2, and to analyze the results, to prevent delaying the Work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Sealants, including a printed statement of VOC content.
 - a) Latex joint sealants.
 - b) Elastomeric joint sealants.
 - c) Acoustical joint sealants.
 - 2) Sealant primers, including a printed statement of VOC content.
 - 3) Plastic foam joint fillers.
 - 4) Bond-breaker tape.
 - 5) Cleaners for nonporous surfaces.
 - 6) Masking tape.
 - b. Samples:
 - 1) Color Charts.
 - 2) Joint sealant Samples for verification.
 - c. Certificates:
 - 1) Asbestos-Free Joint Sealant Certification.
 - 2) Compatibility Certification.
 - 3) Sealant Waterproofing and Restoration Institute (SWR Institute) Validation Certificates.
 - d. Qualification Statements:
 - 1) Joint sealant installer's qualifications.
 - 2) Testing and Inspection Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Compatibility and Adhesion Test Reports.
 - 2) Preconstruction Field Test Reports.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's written installation instructions for the sealant products provided.
 - c. Source Quality Control Submittals:
 - 1) Product Test Reports.
 - d. Site Quality Control Submittals:



- 1) Field Test Report Log.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Special Joint Sealant Installer's Warranty.
 - 2) Special Joint Sealant Manufacturer's Warranty.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Joint Sealant Installer's Qualifications:
 - a. Employ a manufacturer's authorized installer who is approved or licensed for installation of the elastomeric sealants required for this Contract.
 - b. Submit the joint sealant installer's qualifications to the Program/Project Manager for approval.
 2. Testing and Inspection Agency's Qualifications:
 - a. Employ an independent Testing and Inspection Agency qualified, in accordance with the requirements specified in Section 01400, Quality Requirements, and ASTM C 1021 to conduct the testing specified herein, as documented in accordance with the requirements specified in ASTM E 548.
 - b. Submit the independent testing agency's qualifications to the Program/Project Manager for approval.
- B. Certifications:
 1. Asbestos-Free Joint Sealant Certification:
 - a. Submit a certification from the joint sealant manufacturer certifying that the materials provided under this Section are 100 percent asbestos-free.
 2. Compatibility Certification:
 - a. Submit a letter from the manufacturer certifying all sealants are compatible with one another, and with the construction materials with which they will come in contact on the Contract.
 3. Sealant Waterproofing and Restoration Institute (SWR Institute) Validation Certificates:
 - a. Unless the manufacturer has already validated the elastomeric sealants proposed for the Work of this Section under the SWR Institute Liquid Sealant Validation Program, have the manufacturer



submit sealant samples of each elastomeric sealant to the SWR Institute for verification testing of sealant adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

- b. Submit an SWR Institute Validation Certificate for each elastomeric sealant validated to the Program/Project Manager for information.

C. Sustainability Standards Certifications:

1. Adhesives and Sealants Submittal:

- a. For the sealants and sealant primers used within the weatherproofing system, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, signed by the product manufacturer certifying that these products comply with SCAQMD Rule 1168.

D. Preconstruction Testing:

1. Perform preconstruction joint-sealant-substrate tests to determine the adhesion of the sealants to the joint substrates indicated, and whether or not primers may be required.
 - a. The preconstruction joint-sealant-substrate testing will not be required if the joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those that will contact or affect joint sealants.
2. Preconstruction Compatibility and Adhesion Testing:
 - a. Test Procedure:
 - 1) Submit Samples of the materials that will contact or affect joint sealants to the joint-sealant manufacturers for testing as indicated herein.
 - a) Submit not fewer than 8 pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 2) Have the sealant manufacturers determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of the joint sealants to the joint substrates in accordance with the methods specified in ASTM C 1087.
 - 3) Compatibility and Adhesion Test Reports:
 - a) Have the sealant manufacturers prepare Compatibility and Adhesion Test Reports including the following:
 - (1) Verification that materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - (2) An interpretation of the test results, and written recommendations, for the primers and substrate preparation needed for adhesion.



- (a) Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates.
 - b) Submit the Compatibility and Adhesion Test Reports to the Program/Project Manager for Information.
 - b. Acceptance Criteria:
 - 1) Sealants that do not experience adhesive failure in accordance with the criteria specified in ASTM C 1087 pass the Preconstruction Compatibility and Adhesion Testing.
 - 2) For materials failing the Preconstruction Compatibility and Adhesion Testing, obtain the joint-sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
- E. Site Samples:
 - 1. Color Charts:
 - a. Submit the manufacturer's color charts, consisting of strips of cured sealants showing the full range of colors available for each product exposed to view, to the Program/Project Manager for information and initial color selection.
 - 2. Joint Sealant Samples for Verification:
 - a. For each type and color of joint sealant required, submit Samples of the joint sealants placed in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of the exposed surfaces adjacent to the joint sealants to the Program/Project Manager for approval.
- F. Mock-Ups:
 - 1. If mock-ups to verify the selections made from the sample submittals and to demonstrate the aesthetic effects and set quality standards for materials and execution are indicated on the Contract Drawings, incorporate the sealant joints specified in other Sections that are to receive joint sealants specified by reference to this Section in mock-ups of the assemblies at the location, of the size, and complying with other details of the mock-ups indicated on the Contract Drawings or by inserts.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver materials to the Site in original unopened containers or bundles with labels indicating the manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Storage and Handling Requirements:



1. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Environmental Limitations:

- a. Do not proceed with installation of joint sealants under the following conditions:
 - 1) When ambient and substrate temperature conditions are outside limits permitted by the joint sealant manufacturer.
 - 2) When joint substrates are wet.

1.08 WARRANTY

A. Special Joint Sealant Warranties:

1. Special Joint Sealant Installer's Warranty:

- a. Furnish a written Joint Sealant Installer's Warranty on the installer's standard form in which Installer agrees, at no increase in the Contract Price, to repair or replace joint sealants that do not comply with the performance and other requirements specified in this Section within a 3-year warranty period from the date of Substantial Completion; and to repair or replace exterior concrete pavement joint sealants within a 5-year warranty period from the date of Substantial Completion.
 - 1) Submit the Joint Sealant Installer's Warranty to the Program/Project Manager.

2. Special Joint Sealant Manufacturer's Warranty:

- a. Furnish a written Joint Sealant Manufacturer's Warranty in which elastomeric sealant manufacturer agrees, at no increase in the Contract Price, to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within a 10-year warranty period from the date of Substantial Completion
 - 1) Submit the Joint Sealant Manufacturer's Warranty to the Program/Project Manager.

3. Special Joint Sealant Warranty Exclusions:

- a. The special joint sealant warranties specified in this Section exclude deterioration or failure of joint sealants from the following:
 - 1) Movement of the structure resulting in stresses on the sealant exceeding the sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 - 2) Disintegration of joint substrates from natural causes exceeding the design criteria.



- 3) Mechanical damage caused by individuals, tools, or other outside agents.
- 4) Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.01 JOINT SEALANT SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) For each different product required, obtain the joint sealants and accessories for the Work of this Section from a single source and from a single manufacturer to ensure that materials which come in contact with one another will be compatible.
 3. Product Options:
 - a. Colors of Exposed Joint Sealants:
 - 1) Unless otherwise indicated in the Contract Documents, provide materials having the colors selected by the Program/Project Manager from the manufacturer's Color Charts indicating the full range of available colors.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 2. Sustainable Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Architectural Sealants: Not more than 250 grams per Liter less water.



- b) Sealant Primers for Nonporous Substrates: Not more than 250 grams per Liter less water.
 - c) Sealant Primers for Porous Substrates: Not more than 775 grams per Liter less water.
- C. Performance:
 - 1. For exterior applications, provide joint sealants that establish and maintain continuous watertight and airtight joint seals.
 - 2. For interior applications, provide joint sealants that establish and maintain continuous water-resistant and airtight joint seals.
 - 3. Provide joint sealants that do not stain or deteriorate joint substrates.
- D. Design Criteria:
 - 1. Sealant Installation Standard:
 - a. Comply with the recommendations of ASTM C 1193 for the use of joint sealants as applicable to the materials, applications, and conditions indicated.
 - 2. Product Compatibility:
 - a. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under the conditions of service and application indicated based on the testing and field experience of the sealant manufacturer.
 - 3. Sealant Backings:
 - a. Provide sealant backings of a type, and manufactured from a material, complying with the following requirements:
 - 1) Non-staining.
 - 2) Compatible with joint substrates, sealants, primers, and other joint fillers.
 - 3) Manufacturer-approved for the applications indicated based on field experience and laboratory testing.
 - 4. Stain-Test-Response Characteristics:
 - a. Where elastomeric sealants are specified to be non-staining to porous substrates, such as marble, limestone, granite, and sandstone; provide products that have undergone testing in accordance with the method specified in ASTM C 1248, and have not stained the porous joint substrates indicated in the Contract Documents.
 - 5. Suitability for Contact with Food:
 - a. Where elastomeric sealants are indicated to be used for joints that will come in repeated contact with food, provide products that comply with the requirements specified in 21 CFR 177.2600.
 - 6. Product Data:
 - a. Submit Product Data from the manufacturers for each type of product specified and provided under this Section to the Program/Project Manager for approval.
- E. Materials:



1. Latex Joint Sealants:
 - a. Acrylic Latex Joint Sealants
 - 1) Provide single-component acrylic latex sealants complying with the requirements specified in ASTM C 834.
 - a) Sealant #1:
 - (1) Provide acrylic latex caulk complying with the requirements for Type OP, Grade NF sealant specified in ASTM C 834.
 - (2) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; Acrylic Latex 834 Caulk; www.tremcosealants.com.
 - (b) Bostik, Inc., Chem-Calk 600, www.bostik-us.com.
 - (c) Pecora Corporation, AC-20+, www.pecora.com.
 - (d) Sonneborn, Division of BASF Construction Chemicals - Building Systems, Sonolac, www.buildingsystems.basf.com.
 - (e) Approved equal.
 - b. Acoustical Joint Sealants:
 - 1) Sealant #2:
 - a) For exposed and concealed joints, provide the manufacturer's standard non-sag, paintable, non-staining latex sealant complying with the requirements specified in ASTM C 834, and that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies in accordance with the methods specified in ASTM E 90.
 - b) If required by the application, provide acoustical sealants having flame-spread and smoke-developed indexes of less than 25 in accordance with the requirements specified in ASTM E 84.
 - c) Manufacturers:
 - (1) Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant, www.pecora.com.
 - (2) United States Gypsum Co.; SHEETROCK Acoustical Sealant, www.usg.com.
 - (3) Approved equal.
 2. Elastomeric Joint Sealants:
 - a. Provide elastomeric joint sealants complying with the requirements specified in ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for the type, grade, class, and uses related to its exposure and joint substrates.
 - b. Polyurethane Sealants:
 - 1) Provide multi-component polyurethane sealants complying with the requirements of ASTM C 920.



- a) Sealant #3:
 - (1) Provide Type M, Grade NS, Class 25, Use NT, M, A, and O polyurethane sealants capable of 50 percent extension and compression movement.
 - (2) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; Dymeric 240FC; www.tremcosealants.com.
 - (b) Approved equal.
- b) Sealant #4:
 - (1) Provide Type M, Grade P, Class 25, Use T, M, A and O polyurethane sealants.
 - (2) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; THC – 900/901; www.tremcosealants.com.
 - (b) Approved equal.
- c. Urethane Sealant:
 - 1) Sealant #5:
 - a) Provide single-component pourable Type S, Grade P, and Class 25, urethane sealants rated for the following uses:
 - (1) For uses related to exposure, provide urethane sealant rated for Uses T and NT.
 - (2) For uses related to joint substrate, provide urethane sealant rated for Uses M, A, and, as applicable to the joint substrates indicated, O.
 - (a) For galvanized steel and concrete joint substrates, provide Use O urethane sealants.
 - b) Manufacturers:
 - (1) Sika Corporation, Inc.; Sikaflex - 1CSL, www.sikaconstruction.com.
 - (2) Sonneborn, Division of BASF Construction Chemicals - Building Systems, SL 1, www.buildingsystems.basf.com.
 - (3) Tremco, Inc.; Global Sealants Division; Vulkem Nova 300 SSL; www.tremcosealants.com.
 - (4) Approved equal.
- d. Silicone Sealants:
 - 1) Provide single-component silicone sealants complying with the requirements of ASTM C 920.
 - a) Sealant #6:
 - (1) Provide Type S, Grade NS, Class 25, Use NT, M, G, A and O, silicone sealant capable of 50 percent extension and 50 percent compression movement.
 - (2) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; Spectrem 2; www.tremcosealants.com.
 - (b) Approved equal.



- b) Sealant #7:
 - (1) Provide Type S, Grade NS, Class 25, Use NT, M, G, A and O, silicone sealant capable of 100 percent extension and compression movement.
 - (2) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; Spectrem 1; www.tremcosealants.com.
 - (b) Approved equal.
- c) Sealant #8:
 - (1) Provide Type S, Grade NS, Class 25, Use T, A and O, mildew-resistant silicone sealant formulated with fungicide.
 - (2) Color: White.
 - (3) Manufacturers:
 - (a) Tremco, Inc.; Global Sealants Division; Tremsil 600; www.tremcosealants.com.
 - (b) Approved equal.
- d) Sealant #9:
 - (1) Provide Type S, Grade NS, Class 50, neutral-curing silicone sealant capable of 100 percent extension and compression movement.
 - (2) For use related to exposure, provide Use NT (non-traffic).
 - (3) For uses related to joint substrates, provide Uses M, G, A, and, as applicable to joint substrates indicated, O.
 - (a) For coated glass, color anodic aluminum, and galvanized steel joint substrates, provide Use O silicone sealants.
 - (4) Stain-Test-Response Characteristics:
 - (a) Provide silicone sealant that is non-staining to porous substrates in accordance with the requirements specified in ASTM C 1248.
 - (5) Manufacturers:
 - (a) Dow Corning Corporation, 795, www.dowcorning.com.
 - (b) GE Silicones, SilPruf NB SCS9000, www.geadvancedmaterials.com.
 - (c) Approved equal.
- e) Sealant #10:
 - (1) Provide Type S, Grade NS, Class 25, mildew-resistant, neutral-curing silicone sealant.
 - (2) For use related to exposure, provide Use NT (non-traffic).
 - (3) For uses related to joint substrates, provide Uses M, G, A, and, as applicable to joint substrates indicated, O.
 - (a) For ceramic tile, provide Use O silicone sealants.
 - (4) Manufacturers:



- (a) Pecora Corporation, 898, www.pecora.com.
 - (b) Tremco, Inc.; Global Sealants Division;
Tremsil 600 White; www.tremcosealants.com.
 - (c) Approved equal.
- 3. Sealant Primers.
 - a. Where required for the adhesion of the sealant to the joint substrates indicated, provide sealant primer material as recommended by the joint sealant manufacturer as determined from the preconstruction joint-sealant-substrate tests and field tests.
 - b. Provide sealant primers complying with the specified requirements for VOC content.

2.02 ACCESSORIES

- A. Plastic Foam Joint Fillers:
 - 1. Provide preformed, compressible, resilient, non-staining, non-waxing, non-extruding strips of flexible plastic foam of material of the size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - a. Cylindrical Sealant Backings:
 - 1) Provide cylindrical sealant backings complying with the requirements for Type C (closed-cell material with a surface skin) backing specified in ASTM C 1330, and of a size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 2. Provide closed-cell polyethylene foam that is nonabsorbent to liquid water and gas, and that is non-outgassing in its un-ruptured state.
 - a. Manufacturers:
 - 1) Horizontal Applications:
 - a) Industrial Thermo Polymers™ Limited, "HBR", www.tundrafoam.com.
 - b) Approved equal.
 - 2) Vertical Applications:
 - a) Industrial Thermo Polymers™ Limited, closed-cell or soft-type backer rod, www.tundrafoam.com.
 - b) Approved equal.
- B. Bond-Breaker Tape:
 - 1. Provide polyethylene or other plastic bond-breaker tape as recommended by the sealant manufacturer for preventing the sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at the back of the joint where such adhesion would result in sealant failure.
 - 2. Provide self-adhesive tape where applicable.
- C. Cleaners for Nonporous Surfaces:



1. Provide chemical cleaners acceptable to the sealant and sealant backing material manufacturers, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with the joint substrates.

D. Masking Tape:

1. Provide masking tape manufactured from non-staining, nonabsorbent material compatible with the joint sealants and surfaces adjacent to the joints.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Within a 36-month period preceding the commencement of the Work, have the Testing and Inspection Agency test current sealant formulations for compliance with the requirements specified.
2. Elastomeric Joint Sealants Tests:
 - a. Test Procedure:
 - 1) Have the Testing and Inspection Agency test elastomeric joint sealants in accordance with the requirements specified in ASTM C 920, and if applicable in accordance other standard test methods, for compliance with the requirements specified.
 - 2) Elastomeric Joint Sealant Product Test Reports:
 - a) Submit Product Test Reports based on comprehensive testing of the product formulations performed by the Testing and Inspection Agency, indicating that the sealants comply with the requirements specified.
 - b. Acceptance Criteria:
 - 1) Elastomeric joint sealants complying with the requirements specified for the sealant Type, Grade, Class, and Use in ASTM C 920 pass the Elastomeric Joint Sealants Tests.
3. Latex Joint Sealant Tests:
 - a. Test Procedure:
 - 1) Have the Testing and Inspection Agency test latex joint sealants in accordance with the requirements specified in ASTM C 834, and if applicable in accordance ASTM E 84 and ASTM E 90, for compliance with the requirements specified.
 - 1) Latex Joint Sealant Product Test Reports:
 - a) Submit Product Test Reports based on comprehensive testing of the product formulations performed by the Testing and Inspection Agency, indicating that the sealants comply with the requirements specified.
 - b. Acceptance Criteria:
 - 1) Latex joint sealants complying with the requirements specified for the sealant Type and Grade in ASTM C 834, and if applicable with



the airborne sound transmission requirements specified in ASTM E 90 and exhibit the specified flame-spread and smoke-developed indexes when tested in accordance with ASTM E 84, pass the Latex Joint Sealants Tests.

- B. Non-Conforming Work:
 - 1. Do not provide sealants that do not pass the specified testing.
- C. Coordination of Other Tests and Inspections:
 - 1. Sealant tests performed under the SWR Institute Liquid Sealant Validation Program, and validated by the Sealant Waterproofing and Restoration Institute (SWR Institute) Validation Certificates do not need to be repeated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the Installer present, examine the joints indicated to receive joint sealants for compliance with the requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Pre-Installation Testing:
 - 1. Before installing sealants, perform field tests to determine the adhesion of the sealants to the joint substrates indicated for this Contract and whether or not primers may be required.
 - a. Locate the joints indicated on the Contract Drawings to be tested under this Contract; or, if they are not indicated there, locate joints as directed by the Program/Project Manager.
 - 1) Test each type of sealant and joint substrate indicated.
 - b. Notify the Program/Project Manager 7 days in advance of the dates and times when the joints to be tested will be erected.
 - c. Arrange for a technical representative from the joint-sealant manufacturer to witness the tests.
 - 2. Preconstruction Field-Adhesion Test:
 - a. Test Procedure:
 - 1) Test the joint sealants in accordance with the procedures of Method A, Field-Applied Sealant Joint Hand Pull Tab, specified in Appendix X1 of ASTM C 1193.
 - 2) For joints with dissimilar substrates, verify adhesion to each substrate separately.
 - 3) Extend the cut along one side, verifying adhesion to the opposite side; and repeat this procedure for the opposite side.
 - 4) Preconstruction Field Test Reports:



- a) Prepare a test report indicating whether the sealant in the joint connected to the pulled-out portion failed to adhere to the joint substrates or tore cohesively.
 - (1) Include data on the pull distance used to test each type of product and joint substrate.
 - b) Submit the Preconstruction Field Test Reports to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Sealants not evidencing adhesive failure from this testing, in the absence of other indications of noncompliance with the specified requirements, will be considered satisfactory.
 - 2) Retest sealants that fail adhesively, until satisfactory adhesion is obtained.
- C. Evaluation and Assessment:
 - 1. Do not use sealants that fail to adhere to joint substrates during testing.
 - 2. Proceed with installation of joint sealants only after unsatisfactory conditions have been corrected.
 - a. Joint-Width Conditions:
 - 1) Do not proceed with installation of joint sealants where joint widths are less than those allowed by the joint sealant manufacturer for the applications indicated.
 - b. Joint-Substrate Conditions:
 - 1) Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from the joint substrates.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the joint sealants.
- B. Surface Preparation:
 - 1. Surface Cleaning of Joints:
 - a. Immediately before installing joint sealants, clean out the joints to comply with joint sealant manufacturer's written instructions and the following requirements:
 - 1) Remove all foreign material that could interfere with adhesion of the joint sealant from the joint substrates, including dust; paints except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by the sealant manufacturer; old joint sealants; oil; grease; waterproofing; water repellents; water; surface dirt; and frost.
 - 2) Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these



- methods to produce a clean, sound substrate capable of developing an optimum bond with the joint sealants.
- a) Porous joint surfaces include the following:
 - (1) Concrete.
 - (2) Masonry.
 - (3) Unglazed surfaces of ceramic tile.
 - b) Remove loose particles remaining after cleaning the porous joint substrate surfaces by vacuuming or blowing out the joints with oil-free compressed air.
 - 3) Remove laitance and form-release agents from concrete.
 - 4) Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with the adhesion of joint sealants.
 - a) Nonporous joint surfaces include the following:
 - (1) Metal.
 - (2) Glass.
 - (3) Porcelain enamel.
 - (4) Glazed surfaces of ceramic tile.
2. Joint Priming:
- a. Where recommended in writing by the joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests, or prior experience, prime joint substrates.
 - b. Apply primer in accordance with the joint-sealant manufacturer's written instructions.
 - c. Confine the primers to areas of the joint-sealant bond.
 - d. Do not allow spillage or migration of primer onto adjoining surfaces.
3. Masking Tape:
- a. Where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears, provide masking tape.
 - b. Remove masking tape immediately after tooling the joint without disturbing the joint seal.

3.03 INSTALLATION

- A. Comply with the joint-sealant manufacturer's written installation instructions for the products and applications indicated in the Contract Documents unless more stringent requirements apply.
 - 1. Submit the manufacturer's written installation instructions for the sealant products provided to the Program/Project Manager for information.
- B. Sealant Backing Installation:
 - 1. Install sealant backings of the type indicated to support the sealants during application and at the position required to produce the cross-



sectional shapes and depths of the installed sealants relative to joint widths that allow optimum sealant movement capability.

- a. Do not leave gaps between the ends of sealant backings.
- b. Do not stretch, twist, puncture, or tear sealant backings.
- c. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

C. Bond-Breaker Tape Installation:

1. Where sealant backings are not used between the sealants and the back of the joints, install bond-breaker tape behind the sealants.

D. Sealant Installation:

1. Provide sealants as specified in the Schedule 07920-1 in Article 3.08.
 - a. For the use of joint sealants, comply with the recommendations applicable to the materials, applications, and conditions specified in ASTM C 1193.
 - b. For joint sealants in acoustical applications, comply with the recommendations applicable to materials, applications, and conditions specified in ASTM C 919.
 - c. At sawcut joints that receive backer rod and sealant, provide the same sealant as indicated for use in the building.
2. At the same time the backings are installed, install the sealants using proven techniques complying with the following:
 - a. Place sealants so they directly contact and fully wet joint substrates.
 - b. Completely fill the recesses provided for each joint configuration.
 - c. Produce uniform, cross-sectional shapes and depths relative to the joint widths that allow optimum sealant movement capability.
3. Tooling of Non-Sag Sealants:
 - a. Immediately after applying sealants, but before skinning or curing begins, tool the sealants according to the requirements as specified herein to form smooth, uniform beads of the configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of the sealant with the sides of the joint.
 - 1) Unless otherwise indicated, provide concave joint configurations in accordance with Figure 5A in ASTM C 1193.
 - 2) Where indicated, provide flush joint configuration in accordance with Figure 5B in ASTM C 1193.
 - 3) Provide a recessed joint configuration in accordance with Figure 5C in ASTM C 1193, of the recess depth and at the locations indicated.
 - a) Use masking tape to protect the surfaces adjacent to recessed tooled joints.

E. Special Techniques:

1. To seal joints in fire-resistance-rated construction, comply with the requirements specified in Section 07844, Fire-Resistant Joint Sealants.



2. To seal glazing, comply with the requirements specified in Section 08800, Glazing.
3. To seal perimeter joints of gypsum board partitions to reduce sound transmission, comply with the requirements specified in Section 09260, Gypsum Board Assemblies.
4. To seal tile joints, comply with the requirements specified in Section 09310, Ceramic Tile.
5. To seal edge moldings at the perimeters of acoustical ceilings, comply with the requirements specified in Section 09525, Acoustical Panel Ceiling.

F. Interface with Other Work:

1. Joint Priming:
 - a. Prime joint substrates where required based on the written recommendations of the joint sealant manufacturer, preconstruction joint-sealant-substrate tests, or prior experience.
 - b. Apply primer in compliance with the joint sealant manufacturer's written instructions.
 - c. Confine primer to the areas of the joint sealant bond, and do not allow spillage or migration of the primer onto adjoining surfaces.
2. Masking Tape:
 - a. Where required to prevent sealant from contacting adjoining surfaces that would be permanently stained or damaged by such contact, or by cleaning methods required to remove sealant smears, use masking tape.
 - b. Immediately after tooling the sealant, remove the masking tape without disturbing the joint seal.

3.04 FIELD QUALITY CONTROL

A. Site Tests and Inspections:

1. Field-Adhesion Testing:
 - a. Test Procedure:
 - 1) Have the Testing and Inspection Agency test joint-sealant adhesion to joint substrates in accordance with Method A, Field-Applied Sealant Joint Hand Pull Tab, specified in Appendix X1 of ASTM C 1193.
 - a) Perform the testing appropriate for the type of joint-sealant application indicated in the Contract Documents.
 - b) For joints with dissimilar substrates, verify the adhesion to each substrate separately by extending the cut along one side, verifying adhesion to the opposite side, and repeating the procedure for the opposite side.
 - 2) Extent of Testing:



- a) For each type of elastomeric sealant and joint substrate, perform 10 tests of the first 1000 feet of joint length at locations determined by the Program/Project Manager.
 - b) For each 1000 feet of joint length for each type of elastomeric sealant and joint substrate thereafter, or for each floor elevation, perform 1 test.
 - 3) Inspect the sealant joints to verify the joints are completely filled, to verify voids are absence, to verify the joint configurations comply with the specified requirements, and to record the following information:
 - a) Whether the sealants in joints connected to a pulled-out portion failed to adhere to the joint substrates or tore cohesively.
 - (1) Include data on the pull distance used to test each type of product and joint substrate.
 - (2) Compare these results to determine if adhesion passes the sealant manufacturer's field-adhesion hand-pull test criteria.
 - b) Whether the sealants filled the joint cavities, and are free of voids.
 - c) Whether the sealant dimensions and configurations comply with the specified requirements.
 - 4) Field Test Report Log:
 - a) For each elastomeric sealant application, record the test and inspection results in a Field Test Report Log.
 - (1) Include the dates when the sealants were installed, the names of persons who installed sealants, test dates, test locations, whether the joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - b) Submit the Field Test Report Log to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Sealants not evidencing adhesive failure from the testing or noncompliance with other specified requirements will be considered to have satisfactorily passed the Field-Adhesion Testing.
 - a) Joint sealants failing cohesively as described in Method A specified in Appendix X1 of ASTM C 1193 are not considered to have failed adhesively.

B. Non-Conforming Work

1. Remove sealants that fail to adhere to the joint substrates during the testing or to that fail to comply with other requirements.
2. Repair the sealants pulled from the test area by applying new sealants following the same procedures used originally to seal the joints.



- a. Ensure that the original sealant surfaces are clean and that the new sealant contacts the original sealant.
- b. Retest the replacement applications until test results prove the sealants comply with the specified requirements.

3.05 REPAIR

- A. If damage or deterioration of the sealants occurs prior to Substantial Completion, immediately cut out and remove the damaged or deteriorated joint sealants, and replace the removed sealants with new sealant so the installations with repaired areas are indistinguishable from the original Work.

3.06 CLEANING

- A. As the Work progresses, clean off excess sealants or sealant smears adjacent to joints using methods and cleaning materials approved in writing by the manufacturers of the joint sealants and the products in which the joints occur.

3.07 PROTECTION

- A. During and after the sealant curing period, protect joint sealants from contact with contaminating substances, and from damage resulting from construction operations or other causes, so the sealants are not damaged and do not deteriorate by the time of Substantial Completion.

3.08 SCHEDULES

Schedule 07920-1 Sealant Schedule											
Location	Sealant Application	Sealant Number									
		1	2	3	4	5	6	7	8	9	10
Exterior	Joints bordered by glass.						X				
	Joints bordered by plastic.							X			
	Vertical and horizontal non-traffic construction joints in cast-in-place concrete.									X	
	Horizontal traffic joints in cast-in-place concrete.				X	X					
	Vertical control and expansion joints in unit masonry.			X						X	
	Butt joints between metal panels.									X	



Schedule 07920-1 Sealant Schedule											
Location	Sealant Application	Sealant Number									
		1	2	3	4	5	6	7	8	9	10
	Vertical joints between different materials.									X	
	Perimeter joints between concrete, unit masonry, and metal panels; and frames of doors, windows, and louvers.			X						X	
Interior	Vertical control and expansion joints on external walls.			X						X	
	Vertical joints in interior unit masonry and concrete walls and partitions.									X	
	Around plumbing fixtures and in wet areas.								X		X
	Static dry joints to dress appearance.	X									
	Sound control.	X	X								
	Concrete slabs abutting vertical surfaces.				X						
	Perimeter joints of openings to the exterior.									X	
	Expansion, control, contraction, and isolation joints in horizontal ceramic tile in traffic areas.					X					
Interior	Perimeter joints between interior wall surfaces and interior door and window frames, and elevator entrances.	X									
	Specialty perimeters for appearance or weathertightness.			X			X	X			
Exterior/ Interior	Joints between interior and exterior spaces, and other locations requiring an effective weatherproof barrier.			X							



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.1, 1.02.C.7, 1.04.B.2, 1.05.C.1, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System





SECTION 08110

STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for steel doors and steel door and window frames.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 08211 – Flush Wood Doors.
 - 3. Section 08705 - Finish Hardware.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. American National Standards Institute (ANSI):
 - a. ANSI A115.1G – Installation Guide for Doors and Hardware.
 - b. ANSI A115.2 – Specifications for Preparation of 1-3/8” and 1-3/4” Standard Steel Doors and Frames for Series 4000 Bored Locks and Latches.
 - c. ANSI A115.4 - Specifications for Preparation of 1-3/4” Standard Steel Doors and Frames for Manually Operated Lever Extension Flush Bolts.
 - d. ANSI A115.6 - Preparation of 1-3/4” Standard Steel Doors and Steel Frames for Series 2000 Preassembled Door Locks.
 - e. ANSI A115.12 - Specifications for Preparation of 1-3/4” Standard Steel Doors and Steel Frames for Offset Intermediate Pivots.
 - f. ANSI A115.14 - Specifications for Preparation of 1-3/4” Standard Steel Doors for Open Back Strikes.
 - g. ANSI A115.15 - Specifications for Preparation of 1-3/4” Pre-hung Insulated Steel Doors and Steel Frames for Series 4000 Bored Locks and Latches.
 - h. ANSI A115.16 - Installation Guide for Doors and Hardware.



- i. ANSI A115.17 - Specifications for Preparation of 1-3/8" and 1-3/4" Standard Steel Doors and Frames For Double Type Locks.
- j. ANSI A115.18 - Specifications for Standard Steel Door and Steel Frame Preparation for Bored Locks and Latches with Lever Handles for 1-3/8" and 1-3/4" Doors.
- k. ANSI A250.6 – Hardware on Standard Steel Doors (Reinforcement-Application).
- 2. ASTM International (ASTM):
 - a. ASTM A 568/A 568M – Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Allow, Hot-Rolled and Cold-Rolled, General Requirements for.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - d. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - e. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. Door and Hardware Institute (DHI):
 - a. Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - b. NFPA 252 – Standard Methods of Fire Tests or Door Assemblies.
- 6. Steel Door Institute (SDI):
 - a. ANSI/SDI 100 – Recommended Specifications for Standard Steel Doors and Frames.
 - b. SDI 105 - Recommended Erection Instructions For Steel Frames.
 - c. SDI 112 – Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
 - d. SDI 117 – Manufacturing Tolerances Standard Steel Doors and Frames.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:



1. Sequence the erection of the steel door frames provided as the Work of this Section to precede the construction of the adjacent walls.
2. Sequence the installation of steel frames for the wood doors provided under Section 08211, Flush Wood Doors, to precede the Work of that Section.
3. Sequence the installation of door hardware provided under Section 08705, Finish Hardware, for the steel doors provided as the Work of this Section, to follow the installation of the steel doors.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Doors and frames.
 - b. Shop Drawings:
 - 1) Door and frame types.
 - c. Certificates:
 - 1) Steel Door Label Construction Certification.
 - d. Delegated Design Submittals:
 - 1) Schedule of doors and frames.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Steel door and frame manufacturer's installation instructions.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 – Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.



B. Certifications:

1. Steel Door Label Construction Certification:

- a. For steel door assemblies required to be fire-rated and exceeding the limitations of labeled assemblies, submit the manufacturer's certification that each door and frame assembly has been constructed to conform to the design, materials, and construction equivalent to the requirements for labeled construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Protect steel doors and frames during transit and storage at the Site by either crating the doors, or wrapping them with cardboard.
2. Provide additional protection to prevent damage to the finish of factory-finished doors and frames.
3. On delivery, inspect the steel doors and frames for damage, and notify the shipper and supplier if damage is found.
 - a. Minor damages may be repaired provided refinished items match new work and are acceptable to the Program/Project Manager
 - b. Remove damaged items that cannot be repaired and replace the removed items with new, undamaged replacements as directed.

B. Storage and Handling Requirements:

1. Store steel doors and frames under cover at the Site.
2. Place units on minimum 4-inch high wood blocking.
3. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber.
4. If door packaging becomes wet, remove cartons immediately.
5. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 PRODUCTS

2.01 STEEL DOORS AND FRAMES

A. Description:

1. Regulatory Requirements:

- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- b. Fire-Rated Door Assemblies:
 - 1) Where fire-protection ratings are indicated in the Contract Documents, provide door assemblies that comply with the requirements of NFPA 80, and that are listed and labeled, based



- on testing according to NFPA 252, by a testing and inspecting agency acceptable to the Authorities Having Jurisdiction.
2. ENVISION Requirements:
 - a. Recycled Content
 - 1) Provide Steel doors and Frames whose combined post-consumer recycled content and one-half pre-consumer recycled content is no less than 25 percent.
 - 2) Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168.

B. Design Criteria:

1. Steel Door and Frame Standard:
 - a. Design the steel doors and frames in accordance with the requirements of ANSI/SDI 100 and the requirements specified herein.
2. Clearances:
 - a. At jambs and heads, provide a uniform 1/8 inch clearance, except between non-fire-rated pairs of doors provide not more than a 1/4-inch clearance.
 - b. At bottoms, provide not more than 3/ 4 inch clearance.
3. Exposed Fasteners:
 - a. Unless otherwise indicated in the Contract Documents, provide countersunk flat or oval heads for exposed screws and bolts.
4. Hardware Considerations:
 - a. Prepare doors and frames for hardware in accordance with the applicable requirements in ANSI A250.6 and the ANSI A115 Series specifications.
 - 1) Prepare steel doors and frames to receive mortised and concealed hardware according to the final door hardware schedule and templates provided by hardware supplier.
 - 2) Locate hardware as indicated on approved Shop Drawings, or if the hardware is not indicated, locate the hardware in accordance with the Door and Hardware Institute's "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames".
 - b. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.
5. Glazing:
 - a. Coordinate glazing frames and stops with glass and glazing requirements.
6. Security System Components:
 - a. For doors integrated into the facility security system, provide concealed internal conduit and junction boxes.
7. Product Data:



- a. Submit Product Data for each type of door and frame indicated to the Program/Project Manager for approval.
 - 1) Include the door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
8. Shop Drawings:
 - a. Submit Shop Drawings showing the fabrication and installation of standard steel doors and frames to the Program/Project Manager for approval.
 - 1) Include details of each frame type, elevations of the door design types, conditions at the openings, details of the construction, location and installation requirements of door and frame hardware and reinforcements, and details of the joints and connections.
 - 2) Show the coordination of glass and glazing requirements with glazing frames and stops.
 - 3) Show the anchorage and accessory items.
9. Door and Frames Schedule:
 - a. Submit a schedule of doors and frames to the Program/Project Manager for approval.
 - 1) Use the same reference numbers for the details and openings as those on the Contract Drawings.

C. Materials

1. Hot-Rolled Steel Sheets and Strip:
 - a. Provide hot-rolled steel sheets and strip complying with the requirements for Type B Commercial Steel (CS) as specified in ASTM A 568/A 568M and ASTM A 924/A 924M; pickled and oiled; and free of scale, pitting, or surface defects.
2. Cold-Rolled Steel Sheets:
 - a. Provide cold-rolled steel sheets complying with the requirements for Type B Commercial Steel (CS) or Type B Drawing Steel (DS) as specified in ASTM A 1008/A 1008M, and supplied within the standard flatness tolerances as specified in ASTM A 568/A 568M.
3. Galvanized Steel Sheets:
 - a. Provide zinc-coated, mill phosphatized carbon steel sheets complying with the requirements for Type B Commercial Steel (CS) or Type A Deep Drawing Steel (DDS), and hot dip galvanized to Coating Designation G60, in accordance with the requirements specified in ASTM A 653/A 653M and ASTM A 924/A 924M.

D. Steel Doors

1. Provide steel doors of the types, styles, grades, and designs indicated on the Contract Drawings or schedules.
 - a. Provide metal doors complying with the requirements specified in ANSI/SDI-100, for Grade III, Extra Heavy Duty, Model 2, and having minimum 16 gauge steel faces.



- 1) Interior Doors: Cold-rolled sheet steel faces.
- 2) Exterior Doors: Galvanized steel faces.
2. Vertical Edges:
 - a. Fabricate vertical edges from minimum 16-gauge channels that have each face sheet wrapped around the channels to meet at the center of the edge; and with the resulting seam closed, welded shut, and ground smooth.
 - b. Other methods of fabricating edges are acceptable if they provide equivalent strength and concealed seams.
3. Top and Bottom Edges:
 - a. Fabricate top and bottom edges from 16 gauge steel channels.
 - b. Align the back of each channel flush with the top and bottom of the face sheets.
 - c. If inverted channels are used, provide filler caps.
 - d. Ensure that the tops are smooth and flush.
4. Undercut each door as required to clear floor finish.
 - a. Refer to Finish Schedule in the Contract Documents for specific requirements.
5. Hinge Reinforcement:
 - a. Provide 7-gauge steel hinge reinforcement.
6. Mineral-Fiber Insulation: ASTM C 665, Type 1.
 - a. Thermal-Rated (Insulated) Doors: R-value of not less than 12.3 deg F x h x sq. ft./Btu (2.166 K x sq.m/W) when tested according to ASTM C 1363.
7. Glazing: In accordance with the requirements of Section 08800, Glazing.
8. Glazing Stops:
 - a. On the outside of exterior doors and on the secure side of interior doors, provide non-removable stops for glass, louvers, and other panels in doors. Formed integral with hollow metal frames, a minimum of 5/8 inch (16mm) high unless otherwise noted.
 - b. On the inside of glass, louvers, and other panels in doors, provide screw-applied, removable, glazing stops.
 - c. Provide minimum 20 gage steel, or 0.040-inch-thick aluminum, glazing stops.
- E. Steel Door and Window Frames
 1. Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings, of the types and styles shown on the Contract Drawings and schedules.
 - a. Conceal fastenings, unless otherwise indicated.
 - b. Fabricate frames from minimum 14 gauge cold-rolled steel.
 - c. Fabricate frames with mitered and fully welded corners.
 - d. Form exterior frames from 14-gage galvanized steel.
 - 1) Knock-down frames are unacceptable.
 2. Door Silencers:



- a. Except on weather-stripped frames, fabricate stops to receive 3 silencers on the strike jambs of single-door frames, and 2 silencers on the heads of double-door frames.
- 3. Plaster Guards:
 - a. Provide minimum 24-gage steel sheet plaster guards or mortar boxes to close off the interior of openings.
 - 1) Place plaster guards or mortar boxes at the back of hardware cutouts where mortar or other materials might obstruct hardware operation.
- 4. Hinge Reinforcement:
 - a. Provide 7-gauge steel hinge reinforcement.

F. Fabrication

- 1. Fabricate steel door and frame units in accordance with ANSI/SDI-100.
 - a. If practical, fit and assemble the door and frame units in the manufacturer's plant.
 - 1) Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Site.
 - b. Internal Construction:
 - 1) Where appropriate, on the inside of the door's face sheets provide the manufacturer's standard honeycomb, polyurethane, polystyrene, unitized steel grid, vertical steel stiffeners, or rigid mineral fiber core with an internal sound deadener in accordance with the SDI standards.
- 2. Fabricate the exposed faces of doors and panels of non-flush units, including stiles and rails, only from cold-rolled steel.
- 3. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
- 4. Fabricate exterior doors, panels, and frames from galvanized sheet steel in accordance with SDI 112.
 - a. Close the top and bottom edges of exterior doors as an integral part of door construction, or by the addition of 16 gage minimum inverted steel channels.
- 5. Reinforce the steel doors and frames to receive surface-applied hardware.
 - a. Drilling and tapping for surface-applied hardware may be done at the Site.
- 6. All exterior doors shall be insulated.
- 7. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - a. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that glazed lite is capable of being removed independently.
 - b. Provide loose stops and moldings on inside of hollow metal work.
 - c. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.



8. Fabrication Tolerances:
 - a. Fabricate steel doors and frames within the tolerances specified in SDI 117.

G. Shop Finishing Methods

1. Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
 - a. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
 - b. Apply a shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

2.02 ACCESSORIES

A. Astragals:

1. Provide astragals as required by NFPA 80 to provide the fire ratings indicated.

B. Wall Anchors:

1. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Layout the steel door frame locations, and verify that each location is ready to receive the Work of this Section.
2. Examine the steel doors and frames for defects.

B. Evaluation and Assessment:

1. Provide rigid steel doors and frames, neat in appearance, and free from defects including warp and buckle.

3.02 INSTALLATION

A. Install steel doors, frames, and accessories according to the approved Shop Drawings, manufacturer's installation instructions, and as specified.

1. Submit the steel door and frame manufacturer's installation instructions to the Program/Project Manager for information.

B. Placing Frames:

1. Prior to the construction of enclosing new walls and ceilings, erect steel frames in accordance with the requirements of SDI 105, unless otherwise indicated.
 - a. Erect fire-rated frames in accordance with NFPA 80.



- b. Furnish temporary braces and spreaders to provide temporary support for the frames.
 2. On frames that will receive grout, field-apply a 1/8 inch thick asphaltic emulsion coating to the interior cavity of the frames.
 3. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.
 4. In masonry construction, provide 3 wall anchors per jamb; installed adjacent to the hinge location on the hinge jamb, and at corresponding heights on the strike jamb.
 5. After the wall construction is completed, remove the temporary braces and spreaders, leaving the surfaces smooth and undamaged.
- C. Installing Doors:
 1. Fit hollow-metal doors accurately in the frames, within the clearances specified in ANSI/SDI-100.
 2. Fire-Rated Doors:
 - a. Install fire-rated doors within clearances specified in NFPA 80.
- D. Glazing: In accordance with the requirements of Section 08800, Glazing and with hollow metal manufacturer's written instructions.
 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

3.03 REPAIR/RESTORATION

- A. Prime Coat Touchup:
 1. Immediately after installation, sand any rusted or damaged areas of prime coat smooth, and apply compatible air-drying primer to touch up the finish.

3.04 PROTECTION

- A. Protect installed steel doors and frame from damage until Final Acceptance.
- B. Immediately before the final inspection, remove protective wrappings from doors and frames.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/20017	N/A	All	First edition.



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
1	12/20/2017	N/A	1.02.A.1, 1.04.B.2, 2.01.A.2	Add requirements for ENVISION Sustainability Rating System





SECTION 08311

ACCESS DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for wall, floor, and ceiling access doors and frames, including fire-rated access doors and frames.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 09912 - Painting.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ABS: Acrylonitrile butadiene styrene.
 - 2. ITS: An acronym for Intertek testing and Inspection Services providing auditing, inspection, testing certification, and quality assurance.
 - 3. UV: Ultraviolet.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American National Standards Association (ANSI):
 - a. ANSI H35.2 - Dimensional Tolerances for Aluminum Mill Products.
 - b. ANSI H35.2(M) - Dimensional Tolerances for Aluminum Mill Products (Metric).
 - 2. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.



- c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
 - e. ASTM A 480/A 480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - f. ASTM A 568/A 568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 - g. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - h. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
 - i. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - j. ASTM A 879/A 879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
 - k. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - l. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - m. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - n. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - o. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - p. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
3. National Association of Architectural Metal Manufacturers (NAAMM):
- a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.



4. National Fire Protection Association (NFPA):
 - a. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - b. NFPA 251 –Standard Methods of Tests of Fire Endurance of Construction and Materials.
 - c. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies.
 - d. NFPA 288 – Standard Methods of Fire Tests of Fire Door Assemblies Installed Horizontally in Fire-Resistant-Rated Floor Systems.
5. Underwriters Laboratory:
 - a. UL 10B – Standard for Fire Tests of Door Assemblies.
 - b. UL 263 - Standard for Fire Tests of Building Construction and Materials.
6. Society for Protective Coatings (SSPC):
 - a. SSPC-Paint 20 – Zinc-Rich Primers (Type I, “Inorganic,” and Type II, “Organic”).
 - b. SSPC-Paint 25 –Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II.
7. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordination Drawings:
 - a. Prepare Coordination Drawings showing the following information:
 - 1) Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items with concealed framing, suspension systems, piping, ductwork and other construction.
 - 2) Method of attaching door frames to surrounding construction.
 - 3) Ceiling –mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim.
 - b. Submit the Coordination Drawings to the Program/Project manager for approval.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Doors and frames.
 - b. Shop Drawings:
 - 1) Customized doors and frames.
 - 2) Coordination Drawings.
 - c. Samples:
 - 1) Manufacturer's Samples of fire rated door assemblies.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Certified Fire Rated Floor Door test report.
 - b. Manufacturer's Instructions:
 - 1) Access door manufacturer's written installation instructions.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Fire-Rated Access Doors and Frames:
 - a. Provide units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics in accordance with the following method(s); and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to the Authority Having Jurisdiction (AHJ):
 - 1) For vertical access doors: NFPA 252 or UL 10B.
 - 2) For horizontal access doors and frames: ASTM E 119 or UL 263.
- B. Site Samples:
- 1. Upon request, submit manufacturer's Samples of the fire rated door assemblies sized to adequately represent the fire rated door materials.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
- 1. Deliver the materials in the manufacturer's original packaging.
 - 2. Thoroughly inspect the materials upon receipt, and report damaged material to the delivering carrier.
 - a. Note damage on the carrier's freight bill of lading.
- B. Storage and Handling Requirements:
- 1. Store materials in dry, protected, well-vented areas.



- a. Protect fire rated floor doors from moisture prior to installation.

C. Packaging Waste Management:

1. Remove protective wrapping immediately after installation.
2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Access Door and Frame Warranty:
 - a. Warrant the access doors and frames against defects within the 5-year period after the Date of Substantial Completion:
 - 1) Submit an Access Door and Frame Warranty on the access door and frame manufacturer's standard or customized form, without monetary limitation, in which the access door and frame manufacturer agrees to replace access door and frame parts that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.
 - 2) Failures include, but are not limited to, the following:
 - a) Parts that fail to function in normal use.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer List:

1. J.L. Industries, Inc., www.jlindustries.com.
2. Larsen's Manufacturing Company, www.larsensmfg.com.
3. Milco, Inc, www.milcorinc.com.
4. The Williams Brothers Corporation of America, <http://www.wbdoors.com>.
5. The Bilco Company, <http://www.bilco.com/home.asp>.
6. Approved equal.

B. Substitution Limitations:

1. Subject to compliance with the Contract requirements, provide access doors and frames from the manufacturers listed.

C. Description:

1. Regulatory Requirements:
 - a. Comply with the Occupational Safety and Health Administration (OSHA) requirements regarding access door installation.



D. Design Criteria:

1. Product Data:

- a. Obtain the manufacturer's Product Data for each type of door and frame proposed for the Work of this Section.
 - 1) Include construction details relative to the materials, individual components and profiles, finishes, and fire ratings (if required).
- b. Submit the Product Data to the Program/Project Manager for approval.

2. Shop Drawings:

- a. Prepare Shop Drawings for customized doors and frames.
 - 1) Show fabrication and installation details.
 - 2) Include plans, elevations, sections, details, and attachments to other Work.
 - 3) Show profiles, accessories, locations, and dimensions.
- b. Submit the Shop Drawings to the Program/Project Manager for approval.

E. Performance:

1. Fire Rated Floor Doors:

- a. Provide UL-listed (File R15197) fire rated floor doors having a 2-hour rating when exposed to fire from the underside when the door and frame assembly is tested in accordance with the methods specified in ASTM E 119, NFPA 251, and NFPA 288.
 - 1) In the closed position, the temperature on the unexposed surface of the door must not exceed 325 degrees Fahrenheit above ambient for the duration of the 2-hour period.
 - 2) Submit a certified Fire Rated Floor Door test report to certify that the fire rated floor doors proposed for the Work of this Section comply with the fire rating performance specified.

2.02 MANUFACTURED UNITS

A. Flush, Insulated, Fire-Rated Access Doors and Frames with Exposed Trim:

- 1. Fabricate flush, insulated, fire-rated access doors and frames with exposed trim from metallic coated steel sheet.
 - a. Fire-Resistance Rating: One hour.
 - b. Temperature Rise Rating: 250 degrees Fahrenheit at the end of 30 minutes.
 - c. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch
 - d. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch-wide, surface-mounted trim.



- e. Hinges: Continuous piano hinge.
 - f. Automatic Closer: Spring type.
 - g. Latch: Self-latching bolt operated flush screwdriver with interior release.
 - 2. Locations:
 - a. Use flush, insulated, fire-rated access doors and frames in masonry at wall surfaces.
- B. Flush Access Doors and Frames with Exposed Trim:
- 1. Fabricate flush access doors and frames with exposed trim from metallic-coated steel sheet.
 - a. Door: Minimum 0.060-inch- thick sheet metal, set flush with exposed face flange of frame.
 - b. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch- wide, surface-mounted trim.
 - c. Hinges: Spring-loaded concealed pin type.
 - d. Latch: Screwdriver-operated cam latch.
 - 2. Locations:
 - a. Use flush access doors and frames with exposed trim in masonry, gypsum board and ceramic-tile at wall and ceiling surfaces
- C. Exterior, Flush Access Doors and Frames:
- 1. Type 1 Exterior Access Doors
 - a. Provide weatherproof exterior, flush access doors and frames with an extruded door gasket.
 - 1) Door: Minimum 0.036-inch- thick, metallic-coated steel sheet; flush panel construction with 2-inch- thick fiberglass insulation.
 - 2) Frame: Minimum 0.060-inch extruded aluminum.
 - 3) Hinges: Continuous piano hinge, zinc plated.
 - 4) Latch: Dual-action handles.
 - b. Locations:
 - 1) Use Type 1 exterior, flush access doors and frames in masonry wall surfaces.
 - 2. Type 2 Exterior Access Doors:
 - a. Provide weather resistive exterior, flush access doors and frames with an open celled microcellular polyurethane gasket on the frame inside the closed door front, and a closed cell neoprene sponge striping gasket on the frame at the back of the closed door.
 - 1) Doors:
 - a) Provide at a minimum a zinc-dipped 16 gauge steel door having 1-1/2 inch wide trim and a baked grey enamel finish.
 - 2) Insulation:



- a) Provide a double layer of 1 inch thick extruded polystyrene insulation board having an R-value at a mean temperature of 75 degrees Fahrenheit of 5.0 time 2.
 - 3) Frame:
 - a) Provide a zinc-dipped 16 gauge steel frame having a depth of 2-3/8 inches.
 - 4) Hinges:
 - a) Provide continuous zinc plated piano hinges that allow the doors to open 180 degrees.
 - 5) Latches:
 - a) Provide chrome plated "T" type handles having a pivot rod 3-point latch with a keyed cylinder lock that opens only from the outside.
 - 6) Locations:
 - a) Use Type 1 exterior, flush access doors and frames in vertical surfaces at exterior gypsum sheathing assemblies.
 - b) Use Type 1 exterior, flush access doors and frames in vertical surfaces at Portland cement and plaster assemblies.
- D. Aluminum, Flush Access Doors and Frames:
- 1. Fabricate aluminum, flush access doors and frames from aluminum sheet and extruded-aluminum shapes with mill finish.
 - a. Door: Minimum 0.080-inch- thick aluminum sheet with 3/4-inch polystyrene insulation.
 - b. Frame: Minimum 0.060-inch extruded aluminum with 1-1/4-inch- wide rolled flange with foam weatherproof gasket.
 - c. Hinges: Concealed continuous aluminum.
 - d. Latch: Screwdriver-operated cam latch.
 - 2. Locations:
 - a. Use aluminum, flush access doors and frames in masonry and gypsum board wall and ceiling surfaces.
- E. Duct Access Doors:
- 1. Provide insulated, hinged, and gasketed duct access doors having a safety chain.
 - a. Insulation:
 - 1) Provide 1 inch thick fiberglass insulation.
 - b. Gaskets:
 - 1) Provide 1/4 inch thick by 1/2 inch wide gaskets that provide a positive seal.
 - c. Hinges:
 - 1) Provide full length hinges.



2. Construction:
 - a. Fabricate the duct access doors from die-formed 24 gauge steel having notched, knock-over edges; and fabricate the access door frame from die-formed 22 gauge steel.
 - b. Provide a mill galvanized finish for the doors and frames.
3. Fasteners:
 - a. Provide plated steel camlock fasteners.

F. Plastic Access Doors:

1. Provide removable panels locked to a return frame and having a snap friction catch.
2. Construction:
 - a. Fabricate the panels and their frames from high impact acrylonitrile butadiene styrene (ABS) plastic having ultraviolet (UV) stabilizers.
 - b. Provide a white textured finish for the doors and frames.

G. Fire Rated Floor Doors:

1. Provide smooth and easy operating single leaf fire rated vault access doors having controlled operation throughout the entire arc of the opening and closing that is not affected by temperature.
 - a. Provide fire rated floor doors having a fusible link activated closing system that will automatically close and latch the door leaf in the event of fire.
 - b. Lift Assistance:
 - 1) Provide engineered steel compression spring operators enclosed in composite telescopic tubes having an electrocoated acrylic finish.
 - 2) Provide a mechanical hold-open system with a release button that automatically holds the cover in the open position.
2. Covers and Frames:
 - a. Provide 1/4 inch (6mm) thick aluminum covers and frames.
 - b. Covers:
 - 1) Reinforce the aluminum plate so the covers are capable of supporting live loads of 150 pounds per square foot.
 - 2) Apply an intumescent coating to the underside of the covers.
 - 3) Provide covers having a 1-inch fillable pan designed for field installation of architectural flooring material up to 1/2 inch thick.
 - a) Fill the remaining depth with concrete to maintain the fire rating of the door assembly.
 - b) If a finish floor is not desired, fill the pan with 1 inch of concrete.

c. Frames:



- 1) Provide extruded aluminum frames having a built-in anchor flange around the perimeter.
 - a) Apply an intumescent coating to the interior surface of the frames.
3. Hinges:
 - a. Provide a continuous heavy-duty Type 316 stainless steel hinge for each cover.
4. Latches:
 - a. Provide pneumatic self-closing systems that automatically close the door in the event of a fire when heat parts a UL-listed 165 degree Fahrenheit fusible link.
5. Finishes:
 - a. Apply a bituminous coating to an aluminum mill finish on the exterior of the frame.
 - b. Hardware:
 - 1) Zinc plate/chromate seal all hardware other than engineered steel compression spring operators and tubes, and hinges.

2.03 MATERIALS:

- A. Steel Plates, Shapes, and Bars:
 1. Provide steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
- B. Hot-Rolled Steel Sheets:
 1. Provide hot-rolled steel sheets complying with the requirements for Commercial Steel (CS), Type B steel specified in ASTM A 1011/A 1011M, free of scale, pitting, and surface defects; pickled and oiled; and having the minimum thickness indicated representing the specified nominal thickness according to ASTM A 568/A 568M.
- C. Cold-Rolled Steel Sheets:
 1. Provide cold-rolled steel sheets complying with the requirements for Commercial Steel (CS) steel specified in ASTM A 1008/A 1008M; having stretcher-leveled standard of flatness; and having the minimum thickness indicated representing the specified nominal thickness according to ASTM A 568/A 568M.
 - a. Electrolytic zinc-coated steel sheet having a coating complying with the requirements for Class C coating specified in ASTM A 879/A 879M may be substituted at fabricator's option.
- D. Electrolytic Zinc-Coated Steel Sheet:



1. Provide electrolytic zinc-coated steel sheet complying with the requirements for Commercial Steel (CS) steel specified in ASTM A 879/A 879M, with Class C coating and phosphate treatment to prepare surface for painting; and having the minimum thickness indicated representing the specified nominal thickness according to ASTM A 568/A 568M for uncoated base metal.
- E. Metallic-Coated Steel Sheet:
1. Provide metallic-coated steel sheet complying with the requirements for Commercial Steel (CS), Type B steel specified in ASTM A 653/A 653M, with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating; stretcher-leveled standard of flatness; and having the minimum thickness indicated representing the specified nominal thickness according to ASTM A 924/A 924M.
- F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars:
1. Provide stainless-steel sheet, strip, plate, and flat bars complying with the requirements for Type 304 stainless steel specified in ASTM A 666; and having the minimum thickness indicated representing the specified nominal thickness according to ASTM A 480/A 480M.
- G. Aluminum Sheet:
1. Provide aluminum sheet complying with the requirements specified in ASTM B 209, having the alloy and temper recommended by the aluminum producer and finisher for the type of use and finish indicated, and with not less than the strength and durability properties of alloy 5005-H15; and having the minimum thickness indicated representing the specified nominal thickness according to ANSI H35.2 or ANSI H35.2(M).
- H. Stainless-Steel Bars and Shapes:
1. Provide stainless-steel bars and shapes complying with the requirements for Type 304 stainless steel specified in ASTM A 276.
- I. Aluminum Extrusions:
1. Provide aluminum extrusions complying with the requirements for alloy 6063-T6 specified in ASTM B 221.
- J. Drywall Beads:
1. Provide edge trim formed from 0.0299 inch (0.76mm) thick zinc-coated steel sheet formed to receive joint compound, and having the size to suit the thickness of the gypsum board.
- K. Plaster Bead:



1. Provide casing bead formed from 0.0299 inch (0.76mm) thick zinc-coated steel sheet with a flange formed out of expanded metal lath, and sized to suit the thickness of the plaster.

2.04 FINISHES:

A. Primer Materials:

1. Shop Primers:
 - a. Provide primers that comply with Section 09912, Painting.
2. Shop Primer for Ferrous Metal:
 - a. Provide fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in SSPC-Paint 25.
 - b. Selected shop primers for their good resistance to normal atmospheric corrosion, compatibility with the finish paint systems indicated, and having the capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Finish Materials:

1. Metallic-Coated Steel Finishes:
 - a. Galvanizing of Steel Shapes and Plates:
 - 1) Provide hot-dip galvanize items indicated to comply with the following standard applicable:
 - a) For galvanizing steel and iron products:
ASTM A 123/A 123M.
 - b) For galvanizing steel and iron hardware:
ASTM A 153/A 153M.
 - b. Galvanizing Repair Paint:
 - 1) For re-galvanizing welds in steel, provide high-zinc-dust-content paint complying with the requirements specified in SSPC-Paint 20.

C. Shop Finishing Methods:

1. Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.
2. Surface Preparation:
 - a. Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants.
 - b. For galvanized surfaces, apply, after cleaning, a conversion coating suited to the organic coating to be applied over it.
 - c. For metallic-coated surfaces, clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
3. Factory Priming for Field-Painted Finish:



- a. Apply shop primer immediately after cleaning and pretreating.
4. Finish metal fabrications after assembly.

2.05 FABRICATION

- A. Provide access door assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces:
 1. For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes.
 2. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames:
 1. Grind exposed welds smooth and flush with adjacent surfaces.
 - a. Furnish attachment devices and fasteners of the type required to secure the access panels to the types of supports indicated.
 2. Exposed Flanges:
 - a. Provide flanges, 1 to 1-1/2 inches wide nominal, around the perimeter of the frame.
 3. For trimless frames with drywall bead for installation in gypsum board assembly, provide edge trim for the gypsum board securely attached to the perimeter of the frames.
 4. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to the perimeter of the frames.
 5. Provide mounting holes in the frames to attach the frames to metal or wood framing in plaster and drywall construction, and to attach masonry anchors in masonry construction.
 - a. Provide adjustable metal masonry anchors.
- D. Recessed Access Doors:
 1. Form the face of the panel to provide a recess for application of the applied finish.
 2. Reinforce the panel as required to prevent buckling.
- E. Latching Mechanisms:
 1. Furnish the number of latching mechanisms required to hold the doors in a flush, smooth plane when closed.
- F. Extruded Aluminum:



1. After fabrication, apply the manufacturer's standard protective coating on aluminum that will come in contact with concrete.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that related Work has been completed before installing the access doors.
 2. Verify that mounting surfaces are straight and secure.
 3. Verify that substrates are of the proper width.
- B. Evaluation and Assessment:
 1. Prior to installing access doors, report defects to the Program/Project Manager, and correct the defects.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the access doors.
- B. Surface Preparation:
 1. Ensure that substrates are dry, clean, and free of foreign matter.
- C. Demolition / Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Comply with requirements of the Contract Documents, approved Shop Drawings, and the access door manufacturer's written instructions for installing access doors and frames.
 1. Submit the access door manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Set frames accurately in position, and attach them securely to supports with the plane of the face panels aligned with adjacent finish surfaces.
 1. Furnish mechanical fasteners consistent with the fire rated floor door manufacturer's instructions.
- C. Special Techniques:



1. The specified fire rated floor doors are designed for installation in dry interior applications only.
 - a. Consult the manufacturer if fire rated floor doors are to be exposed to the exterior or to high moisture or humidity conditions.

3.04 REPAIR/RESTORATION

- A. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

3.05 ADJUSTING

- A. Adjust doors and hardware after installation for proper operation.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 08331

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for light duty and fire-rated overhead coiling service doors.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 05500 – Metal Fabrications.

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- B. Reference Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
 - 2. ASTM International (ASTM):
 - a. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 4. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
 - 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 6. Intertek Group plc:
 - a. Intertek Directory of Listed Product Search, <http://etlwhidirectory.etlsemko.com>
 - 1) Warnock Hersey Mark Directory.
 - 7. National Fire Protection Association (NFPA):
 - a. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
 - b. NFPA 105 - Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives.



- c. NFPA 252 - Standard Methods of Fire Tests or Door Assemblies.
- 8. Underwriters Laboratory:
 - a. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - b. UL 10B – Standard for Fire Tests of Door Assemblies.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. If other than manual door operators are provided for the overhead coiling doors, coordinate the power requirements of the door operators with the available power supply.
- B. Pre-Installation Meetings:
 - 1. Schedule and conduct a pre-installation conference at the Site in accordance with the requirements specified in Section 01316, Project Meetings, to establish procedures to maintain optimum working conditions, and to coordinate the Work of this Section with related and adjacent Work.
- C. Sequencing:
 - 1. Sequence the erection of overhead coiling doors to follow construction of supporting load bearing walls, and structure is under roof.
- D. Scheduling:
 - 1. Coordinate the overhead coiling door fabrication schedule with construction progress to avoid delaying the work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Overhead coiling doors and accessories.
 - b. Shop Drawings:
 - 1) Overhead coiling door installations and special components.
 - 2) Wiring diagrams.



- c. Samples:
 - 1) Exposed overhead coiling door products.
 - d. Certificates:
 - 1) Seismic Qualification Certificates.
 - 2) Oversize Construction Certification.
 - e. Qualification Statements:
 - 1) Overhead coiling door installer's qualifications.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's written installation instructions.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and Maintenance Manuals for the overhead coiling doors.
 - b. Warranty Documentation:
 - 1) Overhead Coiling Door Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky harbor International Airport will employ



both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Overhead Coiling Door Installer's Qualifications:

- a. Employ a manufacturer's authorized representative who has been trained and approved by the manufacturer to both install and maintain their overhead coiling door units provided under this Contract.
- b. Submit the overhead coiling door installer's qualifications to the Program/Project Manager for approval.

2. Overhead Coiling Door Manufacturer's Qualifications:

- a. Obtain overhead coiling doors that have been manufactured by a manufacturer who has at least 5 years' experience fabricating and installing overhead coiling doors.
- b. Submit the overhead coiling door manufacturer's qualifications, including a list of 5 projects similar in scope and complexity to the Work of this Contract and completed within the last 5 years, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Component, Device, and Accessory Certification:

- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

2. Seismic Qualification Certificates:

- a. For the overhead coiling doors, accessories, and components provided under this Section, submit Seismic Qualification Certificates from manufacturer certifying these items comply with the requirements



specified for seismic performance to the Program/Project Manager for approval.

3. Oversize Construction Certification:
 - a. For door assemblies required to be fire-rated and that exceed the size limitations of labeled assemblies, submit the manufacturer's Oversize Construction Certification certifying that each door assembly has been constructed to conform to the design, materials, and construction equivalent to the requirements for labeled construction.

D. Site Samples:

1. Submit Samples of each exposed overhead coiling door product and of each color and texture to be provided under this Section to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver materials and products in labeled protective packaging.
 - a. Protect overhead coiling doors during transit and storage at the Site by either crating the doors, or wrapping them with cardboard.
2. Provide additional protection to prevent damage to the finish of factory-finished doors.
3. On delivery, inspect the overhead coiling doors for damage, and notify the shipper and supplier if damage is found.
 - a. Minor damages may be repaired provided refinished items match new work and are acceptable to the Program/Project Manager
 - b. Remove damaged items that cannot be repaired and replace the removed items with new, undamaged replacements as directed.

B. Storage and Handling Requirements:

1. Store overhead coiling doors under cover at the Site.
2. Place units on minimum 4-inch high wood blocking.
3. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber.
4. If door packaging becomes wet, remove cartons immediately.

C. Packaging Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Extended Correction Period:

1. Warrant the overhead coiling door materials and workmanship against failures including, but not limited to, the following within the 5 year period after the Date of Substantial Completion:



- a. Water-tightness of the assembly.
2. Submit the written Overhead Coiling Door Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured overhead coiling doors that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. The Contract Drawings indicate the size, profiles, dimensional requirements, and aesthetic effects of the overhead coiling doors.
 - b. Subject to compliance with the requirements indicated in the Contract Documents, other overhead coiling door manufacturers whose products have equal performance characteristics may be considered.
 - c. Source Limitations:
 - 1) For each type of overhead coiling door, provide the doors, guides, motors, and related primary components from a single source from a single manufacturer.
- B. Description:
 1. Service Door:
 - a. Provide an overhead fire-rated coiling door formed with a door curtain of interlocking metal slats.
- C. Performance:
 1. Exterior Door Structural Performance:
 - a. For overhead coiling doors exposed to the exterior of the structure, provide doors capable of withstanding the wind loads, the effects of gravity loads, and loads and stresses within the limits and under the conditions specified in ASCE/SEI 7, and complying with the following requirement:
 - 1) Wind Loads:
 - a) Provide doors capable of withstanding a uniform pressure (velocity pressure) of 20 pounds force per square foot (960Pa), acting inward and outward.
 2. Light Duty Overhead Coiling Structural Performance:
 - a. Curtain/Counterbalance Deflection:



- 1) Provide a curtain/counterbalance mechanism having deflection limited to no more than 0.03 inch per foot.
 3. Seismic Performance:
 - a. Provide overhead coiling doors capable of withstanding the effects of earthquake motions within the limits and under the conditions determined in accordance with the requirements specified in ASCE/SEI 7.
- D. Design Criteria:
 1. Operation Cycles:
 - a. Provide overhead coiling doors designed for not less than 10,000 operation cycles.
 2. Fire Rating:
 - a. Provide fire-rated overhead coiling door assemblies complying with the requirements specified in NFPA 80, and that are listed and labeled by a qualified testing agency acceptable to the Authorities Having Jurisdiction, such as Underwriters Laboratories, Inc. (UL), for fire-protection rating(s) indicated, based on testing at as close to neutral pressure as possible in accordance with the methods specified in NFPA 252 or UL 10B.
 - 1) Fire Protection Rating: 1-1/2 hours.
 - b. Fire-Resistance Rating Approvals:
 - 1) FM Approvals LLC (FM) Listing:
 - a) FM Approvals LLC (FM) furnishes a free online service, The Approval Guide, listing approved assemblies complying with various FM Approval Standards.
 - 2) Intertek Directory of Listed Product Search:
 - a) Intertek Group plc furnishes a free online service listing Warnock Hersey approved assemblies in the Warnock Hersey Mark Directory.
 - 3) Underwriters Laboratories, Inc. (UL) Fire Resistance Directory:
 - a) Underwriters Laboratories, Inc. publishes and the UL Fire Resistance Directory which lists all assemblies, systems, and devices UL has tested, and classifies them under Category Codes (CCN) in the free UL Online Certifications Directory.
 3. Product Data:
 - a. Submit Product Data for each type and size of overhead coiling door and accessory provided under this Section to the Program/Project Manager for approval.
 4. Shop Drawings:
 - a. For each overhead coiling door installation and for special components not dimensioned or detailed in manufacturer's Product Data, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Include plans, elevations, sections, details, and attachments to other work.



- 2) Detail equipment assemblies, including framing members; and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, accessories, anchors, and location and size of each field connection.
 - 3) Show the locations of replaceable fusible links.
 - 4) Show the relationship with adjacent materials.
 - b. Wiring Diagrams:
 - 1) For the overhead coiling doors' power, signal, and control wiring, submit wiring diagrams to the Program/Project Manager for approval.
- E. Operation:
1. Manual Door Operators:
 - a. Unless another type of door operator is indicated on the Contract Drawings to operate the door, provide a chain-hoist operator consisting of an endless hand chain, a chain-pocket wheel and guard, and a gear-reduction unit with a maximum force of 25 pounds-force (111N) for each overhead coiling door.
 - 1) Fabricate the hand chain from alloy-steel.
 - 2) Secure the chain holder to the operator guide.
 - 3) Provide an operator having through-wall shaft operation.
 - 4) Provide an operator having the manufacturer's standard removable operating arm.
- F. Door Assemblies:
1. Fire-Rated Overhead Coiling Service Doors:
 - a. Door Curtains:
 - 1) Provide overhead coiling door curtains fabricated from interlocking galvanized steel slats, and having interior curtain-slat facing fabricated from galvanized steel matching the curtain-slat face on the exterior.
 - a) Provide flat profile slats 2-1/4 inches high, center-to-center.
 - 2) Unless otherwise indicated in the Contract Documents, provide door curtain slats of the thickness and having the mechanical properties recommended by the door manufacturer for the performance, size, and type of door indicated on the Contract Drawings.
 - b. Bottom Bar for Service Doors:
 - 1) For service doors, provide a bottom bar fabricated from similar metal and finished to match the curtain slats, and consisting of 2 angles, each not less than 1-1/2 inches by 1-1/2 inches by 1/8 inch thick (38mm by 38mm by 3mm thick).
 - c. Curtain Jamb Guides:
 - 1) Unless otherwise indicated, provide galvanized steel curtain jamb guides consisting of the manufacturer's standard angles or channels and angles of same finish as the exposed curtain slats.



- 2) Provide curtain jamb guides having sufficient depth and strength to retain the curtain, to allow the curtain to operate smoothly, and to withstand loading.
- 3) Provide slotted bolt holes to allow adjustment of the guide.
- 4) Provide removable stops on the guides to prevent overtravel of the curtain.
- d. Hood:
 - 1) Provide hoods, formed from galvanized sheet steel, and mounted on the face of the interior wall at the opening head of the overhead coiling doors and attached to the end brackets to entirely enclose the coiled curtain and operating mechanism.
 - a) Contour the round shaped hoods to fit the end brackets.
 - b) Roll and reinforce the top and bottom edges of the hood to provide stiffness.
 - c) For surface-mounted hoods and fascia, form closed ends for portions mounted between the jambs that project beyond wall face.
 - 2) Equip the hoods with intermediate support brackets as required to prevent sagging.
 - 3) Provide an automatic drop baffle on fire-rated doors to guard against the passage of smoke or flame.
- e. Locking Devices:
 - 1) Equip the overhead coiling doors with side-locking bolts for padlocks, operable from the coil side; and designed to engage and slide through slots in the tracks to allow the door to be padlocked.
 - 2) Locate the locking device assembly on a single-jamb side.
- f. Counterbalancing Mechanism:
 - 1) Provide the manufacturer's standard mechanism to counterbalance the doors which consists of adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings.
 - 2) Provide grease-sealed bearings or self-lubricating graphite bearings for rotating members.
 - 3) Provide the manufacturer's standard mounting brackets fabricated from either cast iron or cold-rolled steel plate.
- g. Miscellaneous Metal Supports:
 - 1) Provide miscellaneous metal supports complying with the requirements specified in Section 05500, Metal Fabrications.
- h. Finishes:
 - 1) Provide a baked-enamel or powder-coated finish on the overhead coiling doors.
 - 2) Provide finish color as selected by the Program/Project Manager from the manufacturer's full color range.



- i. Manufacturers:
 - 1) Cookson Company, www.cooksondoor.com.
 - 2) Cornell Iron Works, Inc., www.cornelliron.com.
 - 3) Overhead Door Corporation, www.overheaddoor.com.
 - 4) Raynor, www.raynor.com.
 - 5) Southwestern Steel Rolling Door Co.
 - 6) Wayne-Dalton Corp., www.wayne-dalton.com.
 - 7) Approved equal.
- 2. Light Duty Overhead Coiling Service Doors:
 - a. Curtain:
 - 1) Provide roll-formed 26 gauge galvanized steel interlocking slats, each having its end locked from lateral movement by a galvanized steel staking lock system.
 - b. Weatherseals:
 - 1) Provide vinyl bottom seals.
 - c. Bottom Bar:
 - 1) Provide extruded aluminum bottom bars.
 - d. Guides:
 - 1) Provide roll-formed galvanized steel shapes attached to a continuous galvanized wall angle.
 - e. Brackets:
 - 1) Provide galvanized steel brackets to support the counterbalance and curtain.
 - f. Counterbalancing Mechanism:
 - 1) Provide a helical spring torsion spring type counterbalance housed in a steel tube or pipe barrel supporting the curtain.
 - 2) Provide a counterbalance having an adjustable spring tension.
 - g. Manual Operation:
 - 1) Provide doors operated by either a manual push up or chain hoist.
 - h. Locking:
 - 1) Provide an exterior slide lock; or for chain hoist operated doors, provide chain keeper locks.
 - i. Wall Mounting Condition:
 - 1) Provide light duty overhead coiling service doors mounted on the face of the wall.
 - j. Finishes:
 - 1) Provide curtain slats galvanized in accordance with the requirements specified in ASTM A 153/A 153M, and roll-coated with a rust-inhibitive 0.2-mil thick baked-on prime coat and a 0.6-mil thick baked-on polyester top coat.
 - 2) Apply a coat of rust-inhibitive primer to non-galvanized surfaces.
 - 3) Provide a finish color as selected by the Program/Project Manager from the manufacturer's full color range.
 - k. Manufacturers:
 - 1) Overhead Door Corporation, 600 Series, www.overheaddoor.com.



- 2) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Check overhead coiling door openings by taking field measurements before fabrication of the overhead coiling doors, and show the recorded field measurements on the Shop Drawings
 2. With the installer present, examine the substrates and existing conditions for compliance with the requirements for the opening configurations, penetrating items, substrates, supports, and other conditions affecting performance.
 - a. Inspect the overhead coiling door openings before installing the doors.
 - b. Verify that the rough or masonry opening is correct.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation:
 1. Verify that masonry surfaces are visibly dry and free of excess mortar, sand, and other construction debris.

3.03 INSTALLATION

- A. Doors:
 1. Provide the overhead coiling doors and operating equipment with the hardware, anchors, inserts, hangers, and equipment supports necessary for a complete installation.
 - a. Install the overhead coiling doors and operating equipment according to manufacturer's installation instructions and as specified.
 - b. Submit the manufacturer's written installation instructions to the Program/Project Manager for information.
 2. Lubricate the bearings and sliding parts as recommended by the manufacturer.
- B. Special Techniques:
 1. Fire-Rated Doors:
 - a. Install fire-rated doors in accordance with the requirements specified in NFPA 80.
 2. Smoke-Control Doors:
 - a. Install smoke-control doors in accordance with the requirements specified in NFPA 80 and NFPA 105.



3.04 REPAIR/RESTORATION

- A. Touch-up damaged coatings and finishes, and repair minor damage.

3.05 ADJUSTING

- A. Adjust the overhead coiling doors' hardware and moving parts so they function smoothly, and the doors operate easily, and free of warp, twist, and distortion.
- B. Adjust the overhead coiling doors' seals so they provide a weathertight fit around the entire perimeter of the door.

3.06 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Inspections:
 - a. Smoke-Control Doors:
 - 1) Smoke control systems are subject to Special Inspections under the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 2) Smoke-control doors provided under this Section are included in the smoke control systems.

3.07 CLEANING

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by the manufacturer of the material or product being cleaned.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.08 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to be able to adjust, operate, and maintain the overhead coiling doors.

3.09 PROTECTION

- A. Protect installed the overhead coiling doors from damage until Final Acceptance.

3.10 MAINTENANCE

- A. Furnish maintenance data, including a maintenance schedule, for the fire-rated service doors in the Operation and Maintenance Manuals.
 - 1. Submit Operation and Maintenance Manuals for the overhead coiling doors to the Program/Project Manager.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 08411

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for aluminum exterior entrance systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01454 - Mock-Up Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07920 - Joint Sealants.
 - 5. Section 08705 – Finish Hardware
 - 6. Section 08800 – Glazing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADA: Americans with Disabilities Act.
 - 2. ADAAG: Americans with Disabilities Act Accessibility Guidelines.
 - 3. ANSI: American National Standards Institute.
 - 4. CRF: Condensation resistance factor.
 - 5. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
- C. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturer’s Association (AAMA):



- a. AAMA 511 - Voluntary Guideline for Forensic Water Leakage Testing of Fenestration Production.
- b. AAMA 701/702 - Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
- c. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- d. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
3. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - e. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - f. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - g. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - h. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
 - i. ASTM B 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire [Metric].
 - j. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - k. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].



- l. ASTM B 429/B 429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - m. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
 - n. ASTM D 2287 – Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
 - o. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - p. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - q. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
 - r. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- 5. American Welding Society (AWS):
 - a. AWS A5.10/A5.10M – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
- 6. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.1 –Butts and Hinges.
 - b. ANSI/BHMA A156.4 –Door Controls – Closers.
 - c. ANSI/BHMA A156.5 – Auxiliary Locks and Associated Products.
 - d. ANSI/BHMA A156.16 –Auxiliary Hardware.
- 7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 8. Glass Association of North America (GANA):
 - a. GANA Glazing Manual.
- 9. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 10. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 11. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 12. Underwriter's Laboratories, Inc. (UL):
 - a. UL 305 - Standard for Panic Hardware.



13. United States Government:

- a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
- b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
- c. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

14. Institute for Sustainability Infrastructure (ISI):

- a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:

- 1. Coordinate the entrance and storefront system fabrication schedule with construction progress to avoid delaying the work.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Exterior aluminum entrances.
 - 2) Hardware.
 - b. Shop Drawings:
 - 1) Entrance systems and storefront systems.
 - c. Samples:
 - 1) Color charts.
 - 2) Framing intersection Samples.
 - d. Certificates:
 - 1) Installer Certificates.
 - e. Qualification Statements:
 - 1) Aluminum entrance and storefront installer's qualifications.
 - 2) Entrance and Storefront Testing Agency's qualifications.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Product Test Reports.
 - 2) Sealant compatibility and adhesion test reports.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's instructions for protecting and handling entrance and storefront systems.
 - 2) Manufacturer's instructions for installing entrance and storefront systems.
 - c. Sustainable Design Submittals:
 - 1) Low-Emitting Materials: Adhesives & Sealants, Submittal for the aluminum entrances and storefronts.
 - 2) ENVISION Credit RA 1.3 - Use Recycled Materials - Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 3) ENVISION Credit RA 1.4 – Use Regional Materials - Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Aluminum Entrance and Storefront Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ



both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Installer's Qualifications:

- a. Engage an experienced installer who has specialized in installing entrance and storefront systems similar to those required for this Contract, and who is acceptable to manufacturer, to assume engineering responsibility for and to perform the Work of this Section.

1) Engineering Responsibility:

- a) Engineering responsibility includes preparing information for the entrance and storefront systems, including Shop Drawings, based on testing and engineering analysis of the manufacturer's standard units in assemblies similar to those indicated for this Contract.
- b. Submit the aluminum entrance and storefront installer's qualifications to the Program/Project Manager for approval.

2. Entrance and Storefront Testing Agency's Qualifications:

- a. To perform the entrance and storefront testing of the Work of this Section, employ the services of one or more independent certified testing laboratories having the following qualifications:

- 1) Each testing laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 699.

- a) Each testing laboratory must have the experience and capability to satisfactorily perform the reviews, inspections, and testing required of them by this Contract, including but not limited to, inspecting, sampling, and testing proposed materials and systems as required by the Program/Project Manager for compliance with the Contract Documents.
- b) The testing laboratory must be approved by the Program/Project Manager, and must also be accepted by the local jurisdictions responsible for building inspection.
- b. Dismissal and replacement of any of these independent certified testing laboratories by the Contractor requires written notice to and the approval from the Program/Project Manager.
- c. Submit the qualifications and certifications of the proposed testing laboratories to the Program/Project Manager for approval.

C. Certifications:

1. Installer Certificates:



- a. Submit Installer Certificates, signed by the aluminum entrance and storefront manufacturer, certifying that the installer is acceptable to the manufacturer for installing their products.
- D. Sustainability Standards Certifications:
 - 1. Adhesives and Sealants Submittal:
 - a. For the sealants and sealant primers used within the aluminum entrances and storefronts, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components.
 - 1) Certify compliance with SCAQMD Rule 1168.
- E. Site Samples:
 - 1. Color Charts:
 - a. For units with factory-applied color finishes, submit the manufacturer's color charts showing the full range of colors available to the Program/Project Manager for approval.
 - 2. Framing Intersection Samples:
 - a. For each vertical-to-horizontal framing intersection of the systems, submit a cutaway Sample made from minimum 6 inch (150mm) lengths of the full-size components showing details of the following:
 - 1) Joinery.
 - 2) Anchorage.
 - 3) Expansion provisions.
 - 4) Glazing.
 - 5) Flashing and drainage.
- F. Mock-Ups:
 - 1. Build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.
 - a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. Using the glazing methods to be used for production Work, build mockups having the kinds of glass installed as appropriate to match the glazing systems required under this Section:
 - 2. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 - 1. Comply with the manufacturer's written instructions for protecting and handling entrance and storefront systems.



- a. Submit the manufacturer's instructions for protecting and handling entrance and storefront systems to the Program/Project Manager for information.

1.07 WARRANTY

- A. Extended Correction Period:
 1. Warrant the entrance and storefront materials and workmanship against failures including, but not limited to, the following within the 5 year period after the Date of Substantial Completion:
 - a. Water-tightness of the assembly.
 2. Submit the written Aluminum Entrance and Storefront Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured aluminum entrances and storefronts that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Oldcastle Glass®, www.vistawall.com.
 - b. U.S. Aluminum, www.usalum.com.
 - c. Kawneer Company, Inc., www.kawneer.com.
 - d. Southwest Aluminum Systems.
 - e. Approved equal.
 2. Substitution Limitations:
 - a. The Contract Drawings indicate the size, profiles, and dimensional requirements of the entrance and storefront systems, and are based on the specific systems indicated.
 - 1) Except with the Program/Project Manager's approval, do not provide products modifying the intended aesthetic effect indicated in the Contract Documents as judged solely by the Program/Project Manager, and then only to the extent needed to comply with performance requirements.
 - 2) Where modifications to the intended aesthetic effect are proposed, submit comprehensive explanatory data to Program/Project Manager for review and approval.



- b. Subject to compliance with the requirements indicated in the Contract Documents, other manufacturers' systems with equal performance characteristics may be considered.
 - 3. Product Options:
 - a. Source Limitations:
 - 1) Obtain each type of entrance and storefront system through one source and from a single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 2. Sustainability Requirements:
 - 1) Volatile Organic Compounds (VOC) Content of liquid-type auxiliary materials:
 - a) Provide liquid-type auxiliary materials for the polyvinyl-chloride (PVC) roofing system having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, that comply with the volatile organic compounds (VOC) limits of the Authorities Having Jurisdiction, and that comply with SCAQMD Rule 1168.
 - b) Provide materials not exceeding the following volatile organic compound (VOC) limits for ENVISION:
 - (1) For structural glazing adhesives: Not more than 100 grams per Liter less water.
- C. Performance:
 - 1. Wind Loads:
 - a. Provide entrance and storefront systems, including anchorage, capable of withstanding the wind-load design pressures calculated according to requirements of the Authorities Having Jurisdiction or section 6.4.2, Analytical Procedure, in ASCE/SEI 7, whichever are more stringent.
 - 2. Air Infiltration:
 - a. Provide entrance and storefront systems having permanent resistance to air leakage through fixed glazing and frame areas of not more than 0.06 cubic feet per minute per square foot (0.3L/s/m²) of fixed wall



area when tested according to ASTM E 283 at a static-air-pressure difference of 1.57 pounds force per square foot (75.2Pa).

3. Water Penetration:
 - a. Provide entrance and storefront systems that do not evidence water leakage through fixed glazing and frame areas when tested according to ASTM E 331 at minimum differential pressure of 20 percent of the inward-acting wind-load design pressure as defined by ASCE/SEI 7, but not less than 6.24 pounds force per square foot (299Pa).
 - 1) Water leakage is defined as uncontrolled water infiltrating systems or appearing on the systems' normally exposed interior surfaces from sources other than condensation.
 - 2) Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
4. Thermal Movements
 - a. Provide entrance and storefront systems, including anchorage, that accommodate thermal movements of the systems and supporting elements resulting from the following maximum changes (ranges) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects:
 - 1) Ambient Temperature Change (Range): 120 degrees Fahrenheit (67 degrees Celsius).
 - 2) Material Surface Temperature Change (Range): 180 degrees Fahrenheit (100 degrees Celsius).
5. Condensation Resistance:
 - a. Provide storefront systems having a condensation resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.

D. Design Criteria:

1. Dimensional Tolerances
 - a. Provide entrance and storefront systems that accommodate the dimensional tolerances of the building frame and other adjacent construction.
2. Structural-Support Movement:
 - a. Provide entrance and storefront systems that accommodate structural movements including, but not limited to, sway and deflection.
3. Deflection of Framing Members:
 - a. Unless otherwise indicated, allowable deflection of framing members in a direction normal to the wall plane is limited to $L/175$ of the clear span, or 3/4 inch (19 mm), whichever is smaller.



4. Dead Loads:
 - a. Provide entrance- and storefront-system members that do not deflect an amount which will reduce the glazing bite below 75 percent of the design dimension when carrying the full dead load.
 - 1) Provide a minimum 1/8-inch (3.18mm) clearance between the members and the top of the glazing or other fixed part immediately below.
5. Live Loads:
 - a. Provide entrance and storefront systems, including anchorage, that accommodate the supporting structures' deflection from the uniformly distributed and concentrated live loads indicated without failure of materials or permanent deformation.
6. Glazing:
 - a. Physically and thermally isolate glazing from framing members.
7. Thermally Broken Construction:
 - a. Provide systems that isolate aluminum exposed to the exterior from aluminum exposed to the interior with a material of low thermal conductance.
8. Drainage:
 - a. Design system components so water passing joints, condensation, and moisture occurring or migrating within the system will drain to the exterior.
9. Product Data:
 - a. Submit Product Data for the exterior aluminum entrances, and hardware proposed for the Work of this Section to the Program/Project Manager for approval.
10. Shop Drawings:
 - a. For each the entrance systems and storefront systems provided, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Show fabrication and installation details, including plans, elevations, sections, details of the components, provisions for expansion and contraction, and attachments to other work.
 - 2) For entrance systems, include the hardware schedule; and indicate operating hardware types, quantities, and locations.

E. Materials:

1. Aluminum:
 - a. Provide the aluminum alloy and temper recommended by the manufacturer for the type of use and finish indicated, and complying with the requirements of the following standards:
 - 1) Sheet and Plate: ASTM B 209 (ASTM B 209M).



- 2) Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
- 3) Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
- 4) Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
- 5) Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement:
 - a. For structural shapes, plates, and bars, provide materials complying with the requirements specified in ASTM A 36/A 36M.
 - b. For cold-rolled sheet and strip; provide materials complying with the requirements specified in ASTM A 1008/A 1008M.
 - c. For hot-rolled sheet and strip; provide materials complying with the requirements specified in ASTM A 1011/A 1011M.
3. Glazing:
 - a. Provide glazing complying with the requirements specified in Section 08800, Glazing.
4. Glazing Gaskets:
 - a. Provide the manufacturer's standard pressure-glazing system of black, resilient glazing gaskets, setting blocks, and shims or spacers, fabricated from an elastomeric of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements.
 - b. Provide gasket assemblies that have corners sealed with sealant recommended by the gasket manufacturer.
- F. System Components:
 1. Doors:
 - a. Provide the manufacturer's standard 1-3/4 inch (44.5mm) thick glazed doors with extruded tubular rail and stile members a minimum of 0.125 inch (3.2mm) thick.
 - 1) Mechanically fasten the corners with reinforcing brackets that are deep penetration and fillet welded, or that incorporate concealed tie-rods.
 - b. Glazing Stops and Gaskets:
 - 1) Provide the manufacturer's standard snap-on extruded-aluminum glazing stops and preformed gaskets.
 - c. Stile Design:
 - 1) Provide a medium stile having a 3-1/2-inch (88.9mm) nominal width.
 2. Brackets and Reinforcements:
 - a. Provide the manufacturer's standard brackets and reinforcements that are compatible with adjacent materials.



- b. Provide non-staining, nonferrous shims for aligning system components.
 - 3. Fasteners and Accessories:
 - a. Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - b. Reinforce members as required to retain fastener threads.
 - c. Do not use exposed fasteners, except for hardware applications.
 - 1) For hardware applications, use countersunk Phillips flat-head machine screws finished to match the framing members or hardware being fastened unless otherwise indicated in the Contract Documents.
 - 4. Concrete and Masonry Inserts:
 - a. Provide hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with the requirements specified in either ASTM A 123/A 123M or ASTM A 153/A 153M.
 - 5. Concealed Flashing:
 - a. Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing, compatible with adjacent materials, and of a type recommended by manufacturer.
 - 6. Weather Stripping:
 - a. Provide the manufacturer's standard replaceable weather stripping as follows:
 - 1) For compression weather stripping, provide molded neoprene complying with the requirements specified in ASTM D 2000, or molded PVC complying with the requirements specified in ASTM D 2287.
 - 2) For sliding weather stripping, provide wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing complying with the requirements specified in AAMA 701/702.
- G. System Hardware:
 - 1. Provide heavy-duty hardware units of the sizes, number, and type recommended by the manufacturer for the entrances indicated in the Contract Documents.
 - a. Unless otherwise indicated, finish exposed parts to match the door finish.
 - 2. Ball-Bearing Butts:
 - a. Provide 5-knuckle, Grade 1 ball-bearing butts complying with the requirements specified in ANSI/BHMA A156.1.
 - 1) Provide ball-bearing butts sized 4-1/2 inches by 4 inches (101.6mm by 114.3mm).



- 2) Provide non-removable pins at hinges exposed to the door outside, and provide nonferrous hinges for applications exposed to weather.
 - 3) For doors up to 36 inches (914mm) wide and 80 inches (2032mm) tall, provide 3 hinges at each leaf.
 - 4) For doors taller than 80 inches (2032mm), provide 4 hinges at each leaf.
 3. Closers:
 - a. Provide closers complying with the manufacturer's recommendations for the closer size, depending on the door size, exposure to weather, and anticipated frequency of use.
 - 1) Closing Cycle:
 - a) Provide door closers having closing cycles complying with the requirements of the Authorities Having Jurisdiction or the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities, whichever are more stringent.
 - 2) Concealed Overhead Closers:
 - a) Provide Grade 2 concealed overhead closers complying with the requirements specified in ANSI/BHMA A156.4, and the following:
 - (1) Type:
 - (a) Provide the single acting, independently hung type closer, with a concealed arm and track.
 - (2) Hold Open:
 - (a) Provide a closer that automatically holds the door open at the angle selected by the Program/Project Manager from manufacturer's standard options.
 - (3) Back Check:
 - (a) Provide an adjustable back check mechanism.
 - (4) Positive Dead Stop:
 - (a) Provide a positive dead stop coordinated with the hold-open angle, if any, or at an angle selected by the Program/Project Manager from manufacturer's standard options.
 4. Door Stops:
 - a. Provide Grade 1 wall-mounted door stops with an integral rubber bumper complying with the requirements specified in ANSI/BHMA A156.16, as appropriate for the door location indicated in the Contract Documents.
 5. Cylinders:



- a. Have the finish hardware Supplier provide Sargent cylinders and cores as specified under Section 08705, Finish Hardware.
- b. On the interior side of the door, provide a panic release as specified under Section 08705, Finish Hardware.
6. Rim Cylinders:
 - a. On the exterior side of the door, provide the manufacturer's standard Grade 1 rim cylinders complying with the requirements specified in ANSI/BHMA A156.5 for installation in the exit devices.
7. Radius Face Strikes:
 - a. Provide the manufacturer's standard stainless-steel radiused face strike with a steel mounting plate and black-plastic dustbox.
8. Rim-Mounted Exit Devices:
 - a. Provide rim-type exit devices complying with the requirements specified in UL 305, and having one-point latching at the door-lock stile released by a full-width crash bar; or when locked down (dogged), by a lock cylinder or retracting screws beneath the housing.
9. Pull Handles:
 - a. Provide pull handles as selected by the Program/Project Manager from the manufacturer's full range of pull handles and plates.
10. Push Bars:
 - a. Provide push bars as selected by the Program/Project Manager from the manufacturer's full range of full-door-width, single-bar push bars.
 - b. Provide a push plate affixed to push bar.
11. Thresholds:
 - a. At exterior doors, provide the manufacturer's standard aluminum threshold with a mill finish, and having cutouts coordinated for the operating hardware, anchors and jamb clips not more than 1/2 inch (12.7mm) high, and beveled edges providing a floor level change with a slope of not more than 1:2.
12. Weather Sweeps:
 - a. Provide the manufacturer's standard weather sweeps suitable for installation on exterior door bottoms, and having concealed fasteners on mounting strips.

H. Fabrication:

1. Shop Fabrication:
 - a. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
 - 1) Fabricate the components for head- and sill-receptor frame construction, with shear-block construction at the intermediate horizontal components.



- b. Prepare components to receive concealed fasteners, anchor, and connection devices.
 - c. Forming:
 - 1) Form shapes with sharp profiles, straight and free of defects or deformations, prior to finishing the components.
 - d. Welding:
 - 1) Weld components in accordance with the applicable provisions of AWS D1.2/D1.2M.
 - 2) Perform welding operations prior to finishing the components to the greatest extent possible.
 - 3) Perform welding in concealed locations to greatest extent possible to minimize distortion or discoloration of the finish.
 - 4) Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - e. Entrances:
 - 1) Fabricate door framing of the profiles indicated in the Contract Drawings.
 - a) Reinforce the door framing as required to support the imposed loads.
 - b) Factory-assemble the door and frame units, and factory-install hardware to greatest extent possible.
 - c) Reinforce door and frame units as required for installing the hardware indicated in the Contract Documents.
 - d) Cut, drill, and tap for factory-installed hardware before finishing the components.
 - 2) Exterior Doors:
 - a) Provide compression weather stripping at fixed stops.
 - b) At other locations, provide sliding weather stripping retained in adjustable strip mortised into the door edge.
 - 3) Interior Doors:
 - a) Prevent metal to metal contact at stops by providing silencers complying with the requirements specified in ANSI/BHMA A156.16.
 - (1) Provide 3 silencers on the strike jamb of single-door frames, and 2 silencers on the head of double-door frames.
 - f. After fabricating components, clearly mark each component to identify its location in the Work according to the Shop Drawings.
2. Fabrication Tolerances:
- a. Glazing Channels:
 - 1) Provide the minimum clearances according to GANA Glazing Manual for the thickness and type of glass indicated.



- I. Finishes:
 1. Primer Materials:
 - a. Provide the manufacturer's standard corrosion-resistant primer.
 2. Finish Materials:
 - a. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in AA DAF-45.
 - b. High-Performance Organic Coating Finish AA-C12C42R1x:
 - 1) First Chemical Finish: Clean the substrate using inhibited chemicals.
 - 2) Second Chemical Finish: Apply an acid chromate-fluoride-phosphate conversion coating.
 - 3) Organic Coating: Apply the manufacturer's standard 2-coat, thermocured system composed of a specially formulated inhibitive primer and a fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with the requirements specified in AAMA 2605.
 - 4) Color and Gloss: Match the Program/Project Manager's Sample selection.
 3. Shop Finishing Methods:
 - a. Comply with NAAMM AMP 500 for recommendations relative to applying and designating finishes.
 - b. Surface Preparation:
 - 1) Perform the manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair the paint bond.
 - 2) Remove mill scale and rust, if present, from the uncoated steel.
 - c. Metal Protection:
 - 1) Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying a sealant or tape recommended by the manufacturer for this purpose.
 - 2) Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 - d. Priming:
 - 1) Comply with NAAMM AMP 500 for recommendations relative to applying primer.
 - 2) Apply the primer immediately after surface preparation and pretreatment.
 - e. High-Performance Organic Coating Finish AA-C12C42R1x:



- 1) Prepare, pretreat, and apply the high-performance organic coating to exposed metal surfaces in accordance with the coating and resin manufacturer's written instructions.
- f. Appearance of Finished Work:
 - 1) Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples.
 - 2) Noticeable variations in the same piece are not acceptable.
 - 3) Variations in appearance of other components are acceptable if they are within the range of approved Samples, and are assembled or installed to minimize contrast.

2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Provide aluminum entrance and storefront systems capable of withstanding the loads and thermal and structural movement requirements indicated without failure, based on testing the manufacturer's standard units in assemblies similar to those indicated for this Contract.
 - a. Failure includes the following conditions:
 - 1) Air infiltration and water penetration exceeding the specified limits.
 - 2) Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
2. Product Test Reports:
 - a. Based on evaluation of tests performed by the manufacturer, and witnessed by a qualified independent testing agency, submit test reports that indicate compliance of the entrance and storefront systems with the specified requirements based on comprehensive testing of current systems.
3. Static-Pressure Test:
 - a. Test Procedure:
 - 1) Test entrance and storefront systems in accordance with the requirements specified in ASTM E 330 at test pressures of 150 percent of the inward and outward wind-load design pressures.
 - b. Acceptance Criteria:
 - 1) Entrance and storefront systems that do not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of the clear span are acceptable test results.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify dimensions in the field by taking field measurements before fabricating the entrance and storefront systems, and indicate measurements taken on the Shop Drawings.
 - 2. With the Installer present, examine areas to receive entrance and storefront systems for compliance with installation tolerance requirements and other conditions affecting performance.
- B. Pre-Installation Testing:
 - 1. Sealant Compatibility and Adhesion:
 - a. Submit sealant compatibility and adhesion test reports from the sealant manufacturers indicating that the materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with the sealants.
 - 1) Include the joint sealant manufacturers' written interpretation of the test results relative to the sealant performance, and recommendations for primers and substrate preparation needed to obtain adhesion.
- C. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with the manufacturer's written instructions for installing entrance and storefront systems.
 - 1. Submit the manufacturer's instructions for installing entrance and storefront systems to the Program/Project Manager for information.
- B. Do not install damaged components.
- C. Install entrances plumb and true, in alignment with established lines and grades, and without warp or rack.
 - 1. Install framing components plumb and true, in alignment with established lines and grades, and without warping or racking framing members.
- D. Joints:
 - 1. Fit frame joints to produce hairline joints free of burrs and distortion.
 - 2. Rigidly secure non-movement joints.



3. Seal joints so they are watertight.
 - a. Apply sealant in accordance with the requirements specified in Section 07920, Joint Sealants.
 - b. Unless otherwise indicated in the Contract Documents, set continuous sill members and flashing in a full sealant bed to provide weather-tight construction.
 - c. Unless otherwise indicated in the Contract Documents, install perimeter sealant.
- E. Install components to drain water passing joints, condensation, and moisture occurring or migrating within the system to the exterior.
- F. Unless otherwise indicated in the Contract Documents, install glazing in accordance with the requirements specified in Section 08800, Glazing.
- G. Install surface-mounted hardware according to the manufacturer's written instructions using concealed fasteners to greatest extent possible.
 1. Lubricate operating hardware and other moving parts according to the hardware manufacturers' written instructions.
- H. Tolerances:
 1. Erection Tolerances:
 - a. Install entrance and storefront systems in accordance with the following maximum tolerances:
 - 1) Variation from Plane:
 - a) Limit variation from the plane or location shown to 1/8 inch in 12 feet (3mm in 3.7m), and 1/4 inch (6mm) over the total length.
 - 2) Alignment:
 - a) Where surfaces abut in line, limit the offset from true alignment to 1/16 inch (1.5mm).
 - b) Where surfaces meet at corners, limit the offset from true alignment to 1/32 inch (0.8mm).
 - 3) Diagonal Measurements:
 - a) Limit the difference between diagonal measurements to 1/8 inch (3mm).

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Water Spray Test:
 - a. Test Procedure:



- 1) After the test areas indicated on the Contract Drawings have been installed, test the entrance/storefront system for water penetration in accordance with the requirements specified in AAMA 511.
- b. Acceptance Criteria:
 - 1) Entrance/storefront systems complying with the water penetration performance requirements, and the leakage criteria of AAMA 511 are acceptable.
- B. Non-Conforming Work
 1. Repair, or remove and replace, Work that does not meet the specified requirements, or that is damaged by testing.
 - a. Replace nonconforming work to conform to the specified requirements.

3.04 ADJUSTING

- A. Adjust doors and hardware to provide a tight fit at contact points and at weather stripping, smooth operation, and weather-tight closure.

3.05 CLEANING

- A. Remove excess sealant and glazing compounds, and dirt, from surfaces.

3.06 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to the manufacturer and the installer, that ensure entrance and storefront systems are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition
1	12/20/2017	N/A	1.02.A.1, 1.04.B.2, 2.01.A.2	Add requirements for ENVISION Sustainability Rating System





SECTION 08415

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for aluminum exterior entrance systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 07920 - Joint Sealants.
 - 4. Section 08705 – Finish Hardware
 - 5. Section 08800 – Glazing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADA: Americans with Disabilities Act.
 - 2. ADAAG: Americans with Disabilities Act Accessibility Guidelines.
 - 3. ANSI: American National Standards Institute.
 - 4. CRF: Condensation resistance factor.
 - 5. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
- C. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturer’s Association (AAMA):



- a. AAMA 511 - Voluntary Guideline for Forensic Water Leakage Testing of Fenestration Production.
- b. AAMA 701/702 - Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
- c. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- d. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
3. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - e. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - f. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - g. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - h. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
 - i. ASTM B 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire [Metric].
 - j. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - k. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].



- l. ASTM B 429/B 429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - m. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
 - n. ASTM D 2287 – Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
 - o. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - p. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - q. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
 - r. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- 5. American Welding Society (AWS):
 - a. AWS A5.10/A5.10M – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
- 6. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.1 –Butts and Hinges.
 - b. ANSI/BHMA A156.4 –Door Controls – Closers.
 - c. ANSI/BHMA A156.5 – Auxiliary Locks and Associated Products.
 - d. ANSI/BHMA A156.16 –Auxiliary Hardware.
- 7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 8. Glass Association of North America (GANA):
 - a. GANA Glazing Manual.
- 9. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 10. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule #1168 – Adhesive and Sealant Applications.
- 11. Underwriter’s Laboratories, Inc. (UL):
 - a. UL 305 - Standard for Panic Hardware.
- 12. United States Government:



- a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
- b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
- c. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling:
 - 1. Coordinate the entrance and storefront system fabrication schedule with construction progress to avoid delaying the work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Exterior aluminum entrances.
 - 2) Hardware.
 - b. Shop Drawings:
 - 1) Entrance systems and storefront systems.
 - c. Samples:
 - 1) Color charts.
 - 2) Framing intersection Samples.
 - d. Certificates:
 - 1) Installer Certificates.
 - e. Qualification Statements:
 - 1) Aluminum entrance and storefront installer's qualifications.
 - 2) Entrance and Storefront Testing Agency's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Product Test Reports.
 - 2) Sealant compatibility and adhesion test reports.



- b. Manufacturer's Instructions:
 - 1) Manufacturer's instructions for protecting and handling entrance and storefront systems.
 - 2) Manufacturer's instructions for installing entrance and storefront systems.
 - c. Sustainable Design Submittals:
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials - Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 2) ENVISION Credit RA 1.4 – Use Regional Materials - Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Aluminum Entrance and Storefront Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Installer's Qualifications:



- a. Engage an experienced installer who has specialized in installing entrance and storefront systems similar to those required for this Contract, and who is acceptable to manufacturer, to assume engineering responsibility for and to perform the Work of this Section.
 - 1) Engineering Responsibility:
 - a) Engineering responsibility includes preparing information for the entrance and storefront systems, including Shop Drawings, based on testing and engineering analysis of the manufacturer's standard units in assemblies similar to those indicated for this Contract.
 - b. Submit the aluminum entrance and storefront installer's qualifications to the Program/Project Manager for approval.
2. Entrance and Storefront Testing Agency's Qualifications:
 - a. To perform the entrance and storefront testing of the Work this Section, employ the services of one or more independent certified testing laboratories having the following qualifications:
 - 1) Each testing laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 699.
 - a) Each testing laboratory must have the experience and capability to satisfactorily perform the reviews, inspections, and testing required of them by this Contract, including but not limited to, inspecting, sampling, and testing proposed materials and systems as required by the Program/Project Manager for compliance with the Contract Documents.
 - b) The testing laboratory must be approved by the Program/Project Manager, and must also be accepted by the local jurisdictions responsible for building inspection.
 - b. Dismissal and replacement of any of these independent certified testing laboratories by the Construction Manager at Risk requires written notice to and the approval from the Program/Project Manager.
 - c. Submit the qualifications and certifications of the proposed testing laboratories to the Program/Project Manager for approval.
- C. Certifications:
 1. Installer Certificates:
 - a. Submit Installer Certificates, signed by the aluminum entrance and storefront manufacturer, certifying that the installer is acceptable to the manufacturer for installing their products.



D. Sustainability Standards Certifications:

1. ENVISION Adhesives and Sealants Submittal:

- a. For the sealants and sealant primers used within the aluminum entrances and storefronts, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, certifying that these products qualify as Low-Emitting Materials: Adhesives & Sealants.
 - 1) Certify compliance with SCAQMD Rule #1168.

E. Site Samples:

1. Color Charts:

- a. For units with factory-applied color finishes, submit the manufacturer's color charts showing the full range of colors available to the Program/Project Manager for approval.

2. Framing Intersection Samples:

- a. For each vertical-to-horizontal framing intersection of the systems, submit a cutaway Sample made from minimum 6 inch (150mm) lengths of the full-size components showing details of the following:
 - 1) Joinery.
 - 2) Anchorage.
 - 3) Expansion provisions.
 - 4) Glazing.
 - 5) Flashing and drainage.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

- 1. Comply with the manufacturer's written instructions for protecting and handling entrance and storefront systems.
 - a. Submit the manufacturer's instructions for protecting and handling entrance and storefront systems to the Program/Project Manager for information.

1.07 WARRANTY

A. Extended Correction Period:

- 1. Warrant the entrance and storefront materials and workmanship against failures including, but not limited to, the following within the 5 year period after the Date of Substantial Completion:
 - a. Water-tightness of the assembly.
- 2. Submit the written Aluminum Entrance and Storefront Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured aluminum entrances and



storefronts that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.

- a. Have the manufacturer's standard form signed by the Construction Manager at Risk and manufacturer.

PART 2 PRODUCTS

2.01 SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Oldcastle Glass®, www.vistawall.com.
- b. U.S. Aluminum, www.usalum.com.
- c. Kawneer Company, Inc., www.kawneer.com.
- d. Southwest Aluminum Systems.
- e. Approved equal.

2. Substitution Limitations:

- a. The Contract Drawings indicate the size, profiles, and dimensional requirements of the entrance and storefront systems, and are based on the specific systems indicated.
 - 1) Except with the Program/Project Manager's approval, do not provide products modifying the intended aesthetic effect indicated in the Contract Documents as judged solely by the Program/Project Manager, and then only to the extent needed to comply with performance requirements.
 - 2) Where modifications to the intended aesthetic effect are proposed, submit comprehensive explanatory data to Program/Project Manager for review and approval.
- b. Subject to compliance with the requirements indicated in the Contract Documents, other manufacturers' systems with equal performance characteristics may be considered.

3. Product Options:

a. Source Limitations:

- 1) Obtain each type of entrance and storefront system through one source and from a single manufacturer.

B. Sustainability Requirements:

1. ENVISION Credits:

- a. Volatile Organic Compounds (VOC) Content of liquid-type auxiliary materials:

- 1) Provide liquid-type auxiliary materials for the polyvinyl-chloride (PVC) roofing system having volatile organic compound content falling within the following limits when calculated according to



Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, that comply with the volatile organic compounds (VOC) limits of the Authorities Having Jurisdiction, and that comply with SCAQMD Rule #1168.

- 2) Provide materials not exceeding the following volatile organic compound (VOC) limits for ENVISION:
 - a) For structural glazing adhesives: Not more than 100 grams per Liter less water.

C. Performance:

1. Wind Loads:
 - a. Provide entrance and storefront systems, including anchorage, capable of withstanding the wind-load design pressures calculated according to requirements of the Authorities Having Jurisdiction or section 6.4.2, Analytical Procedure, in ASCE/SEI 7, whichever are more stringent.
2. Air Infiltration:
 - a. Provide entrance and storefront systems having permanent resistance to air leakage through fixed glazing and frame areas of not more than 0.06 cubic feet per minute per square foot (0.3L/s/m²) of fixed wall area when tested according to ASTM E 283 at a static-air-pressure difference of 1.57 pounds force per square foot (75.2Pa).
3. Water Penetration:
 - a. Provide entrance and storefront systems that do not evidence water leakage through fixed glazing and frame areas when tested according to ASTM E 331 at minimum differential pressure of 20 percent of the inward-acting wind-load design pressure as defined by ASCE/SEI 7, but not less than 6.24 pounds force per square foot (299Pa).
 - 1) Water leakage is defined as uncontrolled water infiltrating systems or appearing on the systems' normally exposed interior surfaces from sources other than condensation.
 - 2) Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
4. Thermal Movements
 - a. Provide entrance and storefront systems, including anchorage, that accommodate thermal movements of the systems and supporting elements resulting from the following maximum changes (ranges) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects:



- 1) Ambient Temperature Change (Range): 120 degrees Fahrenheit (67 degrees Celsius).
- 2) Material Surface Temperature Change (Range): 180 degrees Fahrenheit (100 degrees Celsius).
5. Condensation Resistance:
 - a. Provide storefront systems having a condensation resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.

D. Design Criteria:

1. Dimensional Tolerances
 - a. Provide entrance and storefront systems that accommodate the dimensional tolerances of the building frame and other adjacent construction.
2. Structural-Support Movement:
 - a. Provide entrance and storefront systems that accommodate structural movements including, but not limited to, sway and deflection.
3. Deflection of Framing Members:
 - a. Unless otherwise indicated, allowable deflection of framing members in a direction normal to the wall plane is limited to $L/175$ of the clear span, or 3/4 inch (19 mm), whichever is smaller.
4. Dead Loads:
 - a. Provide entrance- and storefront-system members that do not deflect an amount which will reduce the glazing bite below 75 percent of the design dimension when carrying the full dead load.
 - 1) Provide a minimum 1/8-inch (3.18mm) clearance between the members and the top of the glazing or other fixed part immediately below.
5. Live Loads:
 - a. Provide entrance and storefront systems, including anchorage, that accommodate the supporting structures' deflection from the uniformly distributed and concentrated live loads indicated without failure of materials or permanent deformation.
6. Glazing:
 - a. Physically and thermally isolate glazing from framing members.
7. Thermally Broken Construction:
 - a. Provide systems that isolate aluminum exposed to the exterior from aluminum exposed to the interior with a material of low thermal conductance.
8. Drainage:
 - a. Design system components so water passing joints, condensation, and moisture occurring or migrating within the system will drain to the exterior.



9. Product Data:
 - a. Submit Product Data for the exterior aluminum entrances, and hardware proposed for the Work of this Section to the Program/Project Manager for approval.
10. Shop Drawings:
 - a. For each the entrance systems and storefront systems provided, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Show fabrication and installation details, including plans, elevations, sections, details of the components, provisions for expansion and contraction, and attachments to other work.
 - 2) For entrance systems, include the hardware schedule; and indicate operating hardware types, quantities, and locations.

E. Materials:

1. Aluminum:
 - a. Provide the aluminum alloy and temper recommended by the manufacturer for the type of use and finish indicated, and complying with the requirements of the following standards:
 - 1) Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - 2) Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
 - 3) Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - 4) Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
 - 5) Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement:
 - a. For structural shapes, plates, and bars, provide materials complying with the requirements specified in ASTM A 36/A 36M.
 - b. For cold-rolled sheet and strip; provide materials complying with the requirements specified in ASTM A 1008/A 1008M.
 - c. For hot-rolled sheet and strip; provide materials complying with the requirements specified in ASTM A 1011/A 1011M.
3. Glazing:
 - a. Provide glazing complying with the requirements specified in Section 08800, Glazing.
4. Glazing Gaskets:
 - a. Provide the manufacturer's standard pressure-glazing system of black, resilient glazing gaskets, setting blocks, and shims or spacers, fabricated from an elastomeric of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements.



- b. Provide gasket assemblies that have corners sealed with sealant recommended by the gasket manufacturer.

F. System Components:

1. Doors:

- a. Provide the manufacturer's standard 1-3/4 inch (44.5mm) thick glazed doors with extruded tubular rail and stile members a minimum of 0.125 inch (3.2mm) thick.
 - 1) Mechanically fasten the corners with reinforcing brackets that are deep penetration and fillet welded, or that incorporate concealed tie-rods.
- b. Glazing Stops and Gaskets:
 - 1) Provide the manufacturer's standard snap-on extruded-aluminum glazing stops and preformed gaskets.
- c. Stile Design:
 - 1) Provide a medium stile having a 3-1/2-inch (88.9mm) nominal width.

2. Brackets and Reinforcements:

- a. Provide the manufacturer's standard brackets and reinforcements that are compatible with adjacent materials.
- b. Provide non-staining, nonferrous shims for aligning system components.

3. Fasteners and Accessories:

- a. Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
- b. Reinforce members as required to retain fastener threads.
- c. Do not use exposed fasteners, except for hardware applications.
 - 1) For hardware applications, use countersunk Phillips flat-head machine screws finished to match the framing members or hardware being fastened unless otherwise indicated in the Contract Documents.

4. Concrete and Masonry Inserts:

- a. Provide hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with the requirements specified in either ASTM A 123/A 123M or ASTM A 153/A 153M.

5. Concealed Flashing:

- a. Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing, compatible with adjacent materials, and of a type recommended by manufacturer.

6. Weather Stripping:



- a. Provide the manufacturer's standard replaceable weather stripping as follows:
 - 1) For compression weather stripping, provide molded neoprene complying with the requirements specified in ASTM D 2000, or molded PVC complying with the requirements specified in ASTM D 2287.
 - 2) For sliding weather stripping, provide wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing complying with the requirements specified in AAMA 701/702.
- G. System Hardware:
 1. Provide heavy-duty hardware units of the sizes, number, and type recommended by the manufacturer for the entrances indicated in the Contract Documents.
 - a. Unless otherwise indicated, finish exposed parts to match the door finish.
 2. Ball-Bearing Butts:
 - a. Provide 5-knuckle, Grade 1 ball-bearing butts complying with the requirements specified in ANSI/BHMA A156.1.
 - 1) Provide ball-bearing butts sized 4-1/2 inches by 4 inches (101.6mm by 114.3mm).
 - 2) Provide non-removable pins at hinges exposed to the door outside, and provide nonferrous hinges for applications exposed to weather.
 - 3) For doors up to 36 inches (914mm) wide and 80 inches (2032mm) tall, provide 3 hinges at each leaf.
 - 4) For doors taller than 80 inches (2032mm), provide 4 hinges at each leaf.
 3. Closers:
 - a. Provide closers complying with the manufacturer's recommendations for the closer size, depending on the door size, exposure to weather, and anticipated frequency of use.
 - 1) Closing Cycle:
 - a) Provide door closers having closing cycles complying with the requirements of the Authorities Having Jurisdiction or the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities, whichever are more stringent.
 - 2) Concealed Overhead Closers:
 - a) Provide Grade 2 concealed overhead closers complying with the requirements specified in ANSI/BHMA A156.4, and the following:



- (1) Type:
 - (a) Provide the single acting, independently hung type closer, with a concealed arm and track.
 - (2) Hold Open:
 - (a) Provide a closer that automatically holds the door open at the angle selected by the Program/Project Manager from manufacturer's standard options.
 - (3) Back Check:
 - (a) Provide an adjustable back check mechanism.
 - (4) Positive Dead Stop:
 - (a) Provide a positive dead stop coordinated with the hold-open angle, if any, or at an angle selected by the Program/Project Manager from manufacturer's standard options.
4. Door Stops:
 - a. Provide Grade 1 wall-mounted door stops with an integral rubber bumper complying with the requirements specified in ANSI/BHMA A156.16, as appropriate for the door location indicated in the Contract Documents.
5. Cylinders:
 - a. Have the finish hardware Supplier provide Sargent cylinders and cores as specified under Section 08705, Finish Hardware.
 - b. On the interior side of the door, provide a panic release as specified under Section 08705, Finish Hardware.
6. Rim Cylinders:
 - a. On the exterior side of the door, provide the manufacturer's standard Grade 1 rim cylinders complying with the requirements specified in ANSI/BHMA A156.5 for installation in the exit devices.
7. Radius Face Strikes:
 - a. Provide the manufacturer's standard stainless-steel radiused face strike with a steel mounting plate and black-plastic dustbox.
8. Rim-Mounted Exit Devices:
 - a. Provide rim-type exit devices complying with the requirements specified in UL 305, and having one-point latching at the door-lock stile released by a full-width crash bar; or when locked down (dogged), by a lock cylinder or retracting screws beneath the housing.
9. Pull Handles:
 - a. Provide pull handles as selected by the Program/Project Manager from the manufacturer's full range of pull handles and plates.
10. Push Bars:
 - a. Provide push bars as selected by the Program/Project Manager from the manufacturer's full range of full-door-width, single-bar push bars.



- b. Provide a push plate affixed to push bar.
- 11. Thresholds:
 - a. At exterior doors, provide the manufacturer's standard aluminum threshold with a mill finish, and having cutouts coordinated for the operating hardware, anchors and jamb clips not more than 1/2 inch (12.7mm) high, and beveled edges providing a floor level change with a slope of not more than 1:2.
- 12. Weather Sweeps:
 - a. Provide the manufacturer's standard weather sweeps suitable for installation on exterior door bottoms, and having concealed fasteners on mounting strips.

H. Fabrication:

- 1. Shop Fabrication:
 - a. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
 - 1) Fabricate the components for head- and sill-receptor frame construction, with shear-block construction at the intermediate horizontal components.
 - b. Prepare components to receive concealed fasteners, anchor, and connection devices.
 - c. Forming:
 - 1) Form shapes with sharp profiles, straight and free of defects or deformations, prior to finishing the components.
 - d. Welding:
 - 1) Weld components in accordance with the applicable provisions of AWS D1.2/D1.2M.
 - 2) Perform welding operations prior to finishing the components to the greatest extent possible.
 - 3) Perform welding in concealed locations to greatest extent possible to minimize distortion or discoloration of the finish.
 - 4) Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - e. Entrances:
 - 1) Fabricate door framing of the profiles indicated in the Contract Drawings.
 - a) Reinforce the door framing as required to support the imposed loads.
 - b) Factory-assemble the door and frame units, and factory-install hardware to greatest extent possible.



- c) Reinforce door and frame units as required for installing the hardware indicated in the Contract Documents.
 - d) Cut, drill, and tap for factory-installed hardware before finishing the components.
 - 2) Exterior Doors:
 - a) Provide compression weather stripping at fixed stops.
 - b) At other locations, provide sliding weather stripping retained in adjustable strip mortised into the door edge.
 - 3) Interior Doors:
 - a) Prevent metal to metal contact at stops by providing silencers complying with the requirements specified in ANSI/BHMA A156.16.
 - (1) Provide 3 silencers on the strike jamb of single-door frames, and 2 silencers on the head of double-door frames.
 - f. After fabricating components, clearly mark each component to identify its location in the Work according to the Shop Drawings.
2. Fabrication Tolerances:
- a. Glazing Channels:
 - 1) Provide the minimum clearances according to GANA Glazing Manual for the thickness and type of glass indicated.
- I. Finishes:
- 1. Primer Materials:
 - a. Provide the manufacturer's standard corrosion-resistant primer.
 - 2. Finish Materials:
 - a. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in DAF-45.
 - b. High-Performance Organic Coating Finish AA-C12C42R1x:
 - 1) First Chemical Finish: Clean the substrate using inhibited chemicals.
 - 2) Second Chemical Finish: Apply an acid chromate-fluoride-phosphate conversion coating.
 - 3) Organic Coating: Apply the manufacturer's standard 2-coat, thermocured system composed of a specially formulated inhibitive primer and a fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with the requirements specified in AAMA 2605.
 - 4) Color and Gloss: Match the Program/Project Manager's Sample selection.
 - 3. Shop Finishing Methods:



- a. Comply with NAAMM AMP 500 for recommendations relative to applying and designating finishes.
- b. Surface Preparation:
 - 1) Perform the manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair the paint bond.
 - 2) Remove mill scale and rust, if present, from the uncoated steel.
- c. Metal Protection:
 - 1) Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying a sealant or tape recommended by the manufacturer for this purpose.
 - 2) Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- d. Priming:
 - 1) Comply with NAAMM AMP 500 for recommendations relative to applying primer.
 - 2) Apply the primer immediately after surface preparation and pretreatment.
- e. High-Performance Organic Coating Finish AA-C12C42R1x:
 - 1) Prepare, pretreat, and apply the high-performance organic coating to exposed metal surfaces in accordance with the coating and resin manufacturer's written instructions.
- f. Appearance of Finished Work:
 - 1) Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples.
 - 2) Noticeable variations in the same piece are not acceptable.
 - 3) Variations in appearance of other components are acceptable if they are within the range of approved Samples, and are assembled or installed to minimize contrast.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Provide aluminum entrance and storefront systems capable of withstanding the loads and thermal and structural movement requirements indicated without failure, based on testing the manufacturer's standard units in assemblies similar to those indicated for this Contract.
 - a. Failure includes the following conditions:
 - 1) Air infiltration and water penetration exceeding the specified limits.



- 2) Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
2. Product Test Reports:
 - a. Based on evaluation of tests performed by the manufacturer, and witnessed by a qualified independent testing agency, submit test reports that indicate compliance of the entrance and storefront systems with the specified requirements based on comprehensive testing of current systems.
3. Static-Pressure Test:
 - a. Test Procedure:
 - 1) Test entrance and storefront systems in accordance with the requirements specified in ASTM E 330 at test pressures of 150 percent of the inward and outward wind-load design pressures.
 - b. Acceptance Criteria:
 - 1) Entrance and storefront systems that do not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of the clear span are acceptable test results.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify dimensions in the field by taking field measurements before fabricating the entrance and storefront systems, and indicate measurements taken on the Shop Drawings.
 2. With the Installer present, examine areas to receive entrance and storefront systems for compliance with installation tolerance requirements and other conditions affecting performance.
- B. Pre-Installation Testing:
 1. Sealant Compatibility and Adhesion:
 - a. Submit sealant compatibility and adhesion test reports from the sealant manufacturers indicating that the materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with the sealants.
 - 1) Include the joint sealant manufacturers' written interpretation of the test results relative to the sealant performance, and recommendations for primers and substrate preparation needed to obtain adhesion.



C. Evaluation and Assessment:

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with the manufacturer's written instructions for installing entrance and storefront systems.

1. Submit the manufacturer's instructions for installing entrance and storefront systems to the Program/Project Manager for information.

B. Do not install damaged components.

C. Install entrances plumb and true, in alignment with established lines and grades, and without warp or rack.

1. Install framing components plumb and true, in alignment with established lines and grades, and without warping or racking framing members.

D. Joints:

1. Fit frame joints to produce hairline joints free of burrs and distortion.
2. Rigidly secure non-movement joints.
3. Seal joints so they are watertight.
 - a. Apply sealant in accordance with the requirements specified in Section 07920, Joint Sealants.
 - b. Unless otherwise indicated in the Contract Documents, set continuous sill members and flashing in a full sealant bed to provide weather-tight construction.
 - c. Unless otherwise indicated in the Contract Documents, install perimeter sealant.

E. Install components to drain water passing joints, condensation, and moisture occurring or migrating within the system to the exterior.

F. Unless otherwise indicated in the Contract Documents, install glazing in accordance with the requirements specified in Section 08800, Glazing.

G. Install surface-mounted hardware according to the manufacturer's written instructions using concealed fasteners to greatest extent possible.

1. Lubricate operating hardware and other moving parts according to the hardware manufacturers' written instructions.

H. Tolerances:

1. Erection Tolerances:



- a. Install entrance and storefront systems in accordance with the following maximum tolerances:
 - 1) Variation from Plane:
 - a) Limit variation from the plane or location shown to 1/8 inch in 12 feet (3mm in 3.7m), and 1/4 inch (6mm) over the total length.
 - 2) Alignment:
 - a) Where surfaces abut in line, limit the offset from true alignment to 1/16 inch (1.5mm).
 - b) Where surfaces meet at corners, limit the offset from true alignment to 1/32 inch (0.8mm).
 - 3) Diagonal Measurements:
 - a) Limit the difference between diagonal measurements to 1/8 inch (3mm).

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Water Spray Test:
 - a. Test Procedure:
 - 1) After the test areas indicated on the Contract Drawings have been installed, test the entrance/storefront system for water penetration in accordance with the requirements specified in AAMA 511.
 - b. Acceptance Criteria:
 - 1) Entrance/storefront systems complying with the water penetration performance requirements, and the leakage criteria of AAMA 511 are acceptable.
- B. Non-Conforming Work
 - 1. Repair, or remove and replace, Work that does not meet the specified requirements, or that is damaged by testing.
 - a. Replace nonconforming work to conform to the specified requirements.

3.04 ADJUSTING

- A. Adjust doors and hardware to provide a tight fit at contact points and at weather stripping, smooth operation, and weather-tight closure.

3.05 CLEANING

- A. Remove excess sealant and glazing compounds, and dirt, from surfaces.



3.06 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to the manufacturer and the installer, that ensure entrance and storefront systems are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition





SECTION 08460

AUTOMATIC ENTRANCE DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for exterior and interior, bi-parting and telescoping, sliding automatic entrances.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures
 - 2. Section 01780 - Closeout Submittals
 - 3. Section 07920 - Joint Sealants
 - 4. Section 08411 - Aluminum-Framed Entrances and Storefronts
 - 5. Section 08710 - Door Hardware
 - 6. Section 08800 - Glazing
 - 7. Division 16 Sections for electrical connections including conduit and wiring for power to sliding automatic entrances.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. DC: Direct electrical current.
 - 3. AAADM: American Association of Automatic Door Manufacturers
- B. Definitions:
 - 1. Activation Device: A device that, when actuated, sends an electrical signal to the door operator to open the door.
 - 2. Safety Device: A device that prevents a door from opening or closing, as appropriate.
- C. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 607.1 – Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum *[withdrawn]*.
 - b. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
 - c. AAMA 701/702 - Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
 - 3. American National Standards Institute (ANSI):



- a. ANSI Z97.1 –Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.
4. American National Standards Association (ANSI):
 - a. ANSI Z97.1 – Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.
5. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.5 - American National Standard for Auxiliary Locks and Associated Products.
 - b. ANSI/BHMA A156.10 - American National Standard for Power Operated Pedestrian Doors.
6. ASTM International (ASTM):
 - a. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
8. Glass Association of North America (GANA):
 - a. GANA Glazing Manual.
9. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
10. International Organization for Standardization (ISO):
 - a. ISO 9001 – Quality Management Systems – Requirements.
11. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM/NOMMA 500– Metal Finishes Manual for Architectural and Metal Products.
12. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 101 – Life Safety Code® (LSC).
13. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
 - b. Parks, Forests, and Public Property:
 - 1) 36 CFR 1192 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
 - c. Consumer Product Safety Commission (CPSC):
 - 1) 16 CFR 1201 Safety Standard for Architectural Glazing Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Templates:



- a. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic entrances to comply with indicated requirements.
2. Electrical System Roughing-in:
 - a. Coordinate layout and installation of automatic entrance door assemblies with connections to power supplies.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.
 - b. Samples:
 - 1) Provide Color Samples for selection of factory-applied color finishes.
- B. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Provide Owner's Manual.
 - b. Warranty Documentation:
 - 1) Provide Warranty Documentation.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Installer Qualifications:
 - a. Manufacturer's authorized representative who is trained for installation and maintenance of units required for this Project.
 2. Manufacturer Qualifications:
 - a. A qualified manufacturer with a manufacturing facility certified under ISO 9001 and with company certificate issued by AAADM.
- B. Certifications:
 1. Automatic sliding door systems shall be certified by the manufacturer to meet performance design criteria in accordance with the following standards:
 - a. ANSI/BHMA A156.10.
 - b. NFPA 101.
 - c. Underwriter's Laboratories 325 (UL) listed.
 - d. IBC.



2. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Emergency-Exit Door Requirements shall comply with requirements of authorities having jurisdiction for automatic entrances serving as a required means of egress.

C. Site Samples:

a. Samples:

- 1) Provide Color Samples for selection of factory-applied color finishes.

1.06 DELIVERY, STORAGE, AND HANDLING

1.07 WARRANTY

A. Manufacturer Warranty:

1. Automatic Entrances shall be free of defects in material and workmanship for a period of one (1) year from the date of substantial completion.
2. During the warranty period the Owner shall engage a factory-trained technician to perform service and affect repairs. A safety inspection shall be performed after each adjustment or repair and a completed inspection form shall be submitted to the Owner.
3. During the warranty period all warranty work, including but not limited to emergency service, shall be performed during normal working hours.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Manufacturer List:

a. Automatic Entrances:

- 1) Stanley Access Technologies; Dura-Glide™ 3000 Series sliding automatic entrances, www.stanleyaccesstechnologies.com.
- 2) Stanley Access Technologies; Dura-Glide™ 5300 Series 3-panel Telescopic Recessed sliding automatic entrances, with access control, www.stanleyaccesstechnologies.com.
- 3) Approved Equal.

2. Substitution Limitations:

- a. Source Limitations: Obtain automatic entrance door assemblies through one source from a single manufacturer.

3. Product Options:

- a. The Contract Drawings indicate sizes, profiles, and dimensional requirements of automatic entrance door assemblies and are based on the specific system indicated.



B. Design Criteria:

1. General:
 - a. Provide automatic entrance door assemblies capable of withstanding structural loads and thermal movements based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
2. Thermal Movements:
 - a. Provide automatic entrances that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1) Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.
3. Operating Range:
 - a. Minus 30 degrees F (Minus 34 degrees C) to 130 degrees F (54 degrees C).
4. Opening-Force Requirements for Egress Doors:
 - a. Not more than 50 lbf (222 N) required to manually set door in motion if power fails, and not more than 15 lbf (67 N) required to open door to minimum required width.
5. Closing-Force Requirements:
 - a. Not more than 30 lbf (133 N) required to prevent door from closing.
6. Shop Drawings:
 - 1) Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.

C. Materials:

1. Automatic Entrance Door Assemblies:
 - a. Provide manufacturer's standard automatic entrance door assemblies including doors, sidelights, framing, headers, carrier assemblies, roller tracks, door operators, activation and safety devices, and accessories required for a complete installation.
 - b. Sliding Automatic Entrances:
 - 1) Configuration: Bi-parting to have Two sliding leaves and two full sidelights. Telescoping Door to have Two sliding leaves and one full sidelight.
 - 2) Traffic Pattern: Two-way.
 - 3) Emergency Breakaway Capability: Sliding leaves.
 - 4) Mounting: Between jambs, or Recessed.
2. Aluminum:
 - a. Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1) Headers, stiles, rails, and frames: 6063-T6.



- 2) Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
- 3) Sheet and Plate: ASTM B 209.
3. Components:
 - a. Framing Members:
 - 1) Manufacturer's standard extruded aluminum reinforced as required to support imposed loads.
 - a) Nominal Size: 1 3/4 inch by 6 inch (45 by 150 mm).
 - b) Concealed Fastening: Framing shall incorporate a concealed fastening pocket, and continuous flush insert cover, extending full length of each framing member.
 - 2) Stile and Rail Doors and Sidelights:
 - a) Manufacturer's standard 1 3/4 inch (45 mm) thick glazed doors with extruded-aluminum tubular stile and rail members. Incorporate concealed tie-rods that span full length of top and bottom rails or mechanically fasten corners with reinforcing brackets that are welded.
 - (1) Glazing Stops and Gaskets: Snap-on, extruded-security aluminum stops and preformed gaskets.
 - (2) Stile Design: Medium stile; 2 inch (50 mm) nominal width.
 - (3) Bottom Rail Design: 12 inch (310 mm) nominal height.
 - (4) Muntin Bars: None.
 - 3) Glazing: Provide glazing for sliding automatic entrances as follows:
 - a) Provide safety glass complying with ANSI Z97.1 and 16 CFR 1201 for Category II materials.
 - b) Safety Glass: 1/4 inch (6 mm) clear, fully tempered, in all panels.
 - 4) Headers:
 - a) Fabricated from extruded aluminum and extending full width of automatic entrance door units to conceal door operators, carrier assemblies, and roller tracks. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
 - (1) Mounting: Concealed, with one side of header flush with framing.
 - (2) Capacity: Capable of supporting up to 220 lb (100 kg) per panel, up to four panels, over spans up to 14 feet (4.3 m) without intermediate supports.
 - 5) Carrier Assemblies and Overhead Roller Tracks:
 - a) Manufacturer's standard carrier assembly that allows vertical adjustment of at least 1/8 inch (3 mm); consisting of urethane with precision steel lubricated ball-bearing wheels, operating on a continuous roller track.



- b) Support panels from carrier assembly by 2 inch (51 mm) diameter anti-riser wheels with factory adjusted cantilever and pivot assembly.
 - c) Minimum two ball-bearing roller wheels and two anti-rise rollers for each active leaf.
 - d) Minimum load wheel diameter shall be 2 1/2 inch (64 mm).
 - 6) Thresholds: Manufacturer's standard thresholds as indicated below:
 - a) Continuous standard tapered extrusion double bevel.
 - b) All thresholds to conform to details and requirements for code compliance.
 - 7) Fasteners and Accessories:
 - a) Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - 8) Signage: Provide signage in accordance with ANSI/BHMA A156.10.
- 4. Door Operators:
 - a. General:
 - 1) Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, operation under normal traffic load for type of occupancy indicated.
 - b. Electromechanical Operators:
 - 1) Self-contained overhead unit powered by a minimum of 1/4 horsepower, permanent-magnet DC motor with gear reduction drive, microprocessor controller; and encoder.
 - a) Operation: Power opening and power closing.
 - b) Features:
 - (1) Adjustable opening and closing speeds.
 - (2) Adjustable back-check and latching.
 - (3) Adjustable braking.
 - (4) Adjustable hold-open time between 0 and 30 seconds.
 - (5) Obstruction recycle.
 - (6) On/Off switch to control electric power to operator.
 - (7) Energy conservation switch that reduces door-opening width.
 - (8) Closed loop speed control with active braking and acceleration.
 - (9) Variable obstruction recycle time delay.
 - (10) Self-adjusting stop position.
 - (11) Self-adjusting closing compression force.
 - (12) Optional Switch to open/Switch to close operation.
 - c) Mounting: Concealed.
 - d) Drive System: Synchronous belt type.



- c. Electrical service to door operators shall be provided under Division 16 Electrical. Minimum service to be 120 Volts AC, 5 amps.
- 5. Electrical Controls:
 - a. Electrical Control System:
 - 1) Electrical control system shall include a microprocessor controller and position encoder. The encoder shall monitor revolutions of the operator shaft and send signals to microprocessor controller to define door position and speed. Systems utilizing external magnets and magnetic switches are not acceptable. A single controller shall be capable of controlling up to two (2) operators per entrance system.
 - b. Life Cycle Data Counter:
 - 1) The electrical control system shall incorporate a non-re-settable counter to track door operation cycles.
 - c. Controller Protection:
 - 1) The microprocessor controller shall incorporate the following features to ensure trouble free operation:
 - a) Automatic Reset Upon Power Up.
 - b) Main Fuse Protection.
 - c) Electronic Surge Protection.
 - d) Internal Power Supply Protection.
 - e) Resettable sensor supply fuse protection.
 - f) Motor Protection, over-current protection.
 - 2) Soft Start/Stop:
 - a) A "soft-start" "soft-stop" motor driving circuit shall be provided for smooth normal opening and recycling.
 - 3) Obstruction Recycle:
 - a) Provide system to recycle the sliding panels when an obstruction is encountered during the closing cycle. If an obstruction is detected, the system shall search for that object on the next closing cycle by reducing door closing speed prior to the previously encountered obstruction location, and will continue to close in check speed until doors are fully closed, at which time the doors will reset to normal speed. If obstruction is encountered again, the door will come to a full stop. The doors shall remain stopped until obstruction is removed and operate signal is given, resetting the door to normal operation.
 - 4) Programmable Controller:
 - a) Microprocessor controller shall be programmable and shall be designed for connection to a local configuration tool. Local configuration tool shall be software driven and shall be utilized via Palm® handheld interface. The following parameters may be adjusted via the configuration tool.



- (1) Operating speeds and forces as required to meet ANSI/BHMA A156.10.
 - (2) Adjustable and variable features as specified in Subparagraph 2.01.C.4.b.1.b.
 - (3) Reduced opening position.
 - (4) Fail Safe/Secure control.
 - (5) Firmware update.
 - (6) Trouble Shooting:
 - (a) I/O Status.
 - (b) Electrical component monitoring including parameter summary.
 - (7) Software for local configuration tool shall be available as a free download from the sliding automatic entrance manufacturer's internet site.
6. Activation and Safety Devices:
 - a. Motion Sensors:
 - 1) Motion sensors shall be mounted on each side of door header to detect pedestrians in the activating zone, and to provide a signal to open doors in accordance with ANSI/BHMA A156.10. Units shall be programmable for bi-directional or uni-directional operation and shall incorporate K-band microwave frequency to detect all motion in both directions.
 - b. Presence Sensors:
 - 1) Presence sensors shall be provided to sense people or objects in the threshold safety zone in accordance with ANSI/BHMA A156.10.
 - 2) Units shall be self-contained, fully adjustable, and shall function accordingly with motion sensors provided.
 - 3) The sensor shall be enabled simultaneously with the door-opening signal and shall emit an elliptical shaped infrared presence zone, centered on the doorway threshold line.
 - 4) Presence sensors shall be capable of selectively retuning to adjust for objects which may enter the safety zone; tuning out, or disregarding, the presence of small nuisance objects and not tuning out large objects regardless of the time the object is present in the safety zone.
 - 5) The door shall close only after all sensors detect a clear surveillance field.
 - c. Photoelectric Beams:
 - 1) In addition to the threshold sensor include a minimum of two (2) doorway holding beams. Photoelectric beams shall be pulsed infrared type, including sender receiver assemblies for recessed mounting.
7. Hardware:
 - a. General:



- 1) Provide units in sizes and types recommended by automatic entrance door and hardware manufacturers for entrances and uses indicated.
- b. Emergency Breakaway Feature:
 - 1) Provide release hardware that allows panel(s) to swing out in direction of egress to full 90 degrees from any position in sliding mode. Maximum force to open panel shall be 50 lbf (222 N) according to ANSI/BHMA A156.10. Interrupt powered operation of panel operator while in breakaway mode.
 - a) Emergency breakaway feature shall include at least one adjustable detent device mounted in the top of each breakaway panel to control panel breakaway force.
 - b) Limit Arms: Limit arms shall be provided to control swing of non-sliding panels on break-out; swing shall not exceed 90 degrees.
- c. Deadlocks:
 - 1) Manufacturer's standard deadbolt operated by exterior cylinder and interior thumb turn; with minimum 1 inch (25 mm) long throw bolt; ANSI/BHMA A156.5, Grade 1.
 - a) Cylinders: As specified in Division 8 Section "Door Hardware."
 - b) Hook Latch: Laminated-steel hook, mortise type, BHMA A156.5, Grade 1.
 - c) Two-Point Locking: Provide locking system that incorporates a device in the stile of active door leaves that automatically extends a flush bolt into overhead carrier assembly.
- d. Control Switch:
 - 1) Provide manufacturer's standard header mounted rocker switches and door position switch to allow for full control of the automatic entrance door. Controls to include, but are not limited to:
 - a) Power On/Off.
 - b) One-way traffic.
 - c) Reduced Opening.
 - d) Open/Closed/Automatic.
- e. Sliding Weather Stripping:
 - 1) Manufacturer's standard replaceable components complying with AAMA 701; made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- f. Weather Sweeps:
 - 1) Manufacturer's standard adjustable nylon brush sweep mounted to underside of door bottom.

D. Assembly:

1. Factory Assembly
 - a. General:



- 1) Factory fabricates automatic entrance door assembly components to designs, sizes, and thickness indicated and to comply with indicated standards.
 - a) Form aluminum shapes before finishing.
 - b) Use concealed fasteners to greatest extent possible.
 - (1) Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - (2) Reinforce members as required to receive fastener threads.
 - b. Framing:
 - 1) Provide automatic entrances as prefabricated assemblies.
 - a) Fabricate tubular and channel frame assemblies with manufacturer's standard mechanical or welded joints. Provide sub-frames and reinforcement as required for a complete system to support required loads.
 - b) Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 - c) Form profiles that are sharp, straight, and free of defects or deformations.
 - d) Prepare components to receive concealed fasteners and anchor and connection devices.
 - e) Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
 - c. Doors:
 - 1) Factory fabricated and assembled in profiles indicated.
 - 2) Reinforce as required to support imposed loads and for installing hardware.
 - d. Door Operators:
 - 1) Factory fabricated and installed in headers, including adjusting and testing.
 - e. Glazing:
 - 1) Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated.
 - f. Hardware:
 - 1) Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site.
- E. Finishes:
1. Finish Materials:
 - a. Aluminum Finishes:
 - 1) General:
 - a) Comply with NAAMM Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designing



finishes. Finish designations prefixed by AA comply with system established by Aluminum Association for designing finishes.

- 2) Class II, Clear Anodic Finish: AA-M10C22A31 Mechanical Finish: as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.40 mils minimum complying with AAMA 611, and the following:
 - a) AAMA 607.1.
 - b) Applicator must be fully compliant with all applicable environmental regulations and permits, including wastewater and heavy metal discharge.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine conditions for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances. Proceed with installation only after unsatisfactory conditions have been corrected.
 2. Field Measurements:
 - a. General Contractor shall verify openings to receive automatic entrance door assemblies by field measurements before fabrication and indicate measurements on Shop Drawings.
 3. Mounting Surfaces:
 - a. General Contractor shall verify all surfaces to be plumb, straight and secure; substrates to be of proper dimension and material.
 4. Other trades:
 - a. General Contractor shall advise of any inadequate conditions or equipment.

3.02 INSTALLATION

- A. General:
 1. Do not install damaged components.
 2. Fit frame joints to produce joints free of burrs and distortion.
 3. Rigidly secure non-movement joints.
- B. Entrances:
 1. Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - a. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - b. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.



- C. Door Operators:
 - 1. Connect door operators to electrical power distribution system as specified in Division 16 Sections.
- D. Glazing:
 - 1. Glaze sliding automatic entrance door panels in accordance with, the Glass Association of North America (GANA) Glazing Manual, published recommendations of glass product manufacturer, and sliding automatic entrance manufacturer's instructions.
- E. Sealants:
 - 1. Comply with requirements specified in Section 07920 - Joint Sealants to provide weather tight installation.

3.03 SITE QUALITY CONTROL

- 1. Inspections:
 - a. Testing Services: Factory Trained Installer shall test and inspect each automatic entrance door to determine compliance of installed systems with applicable ANSI standards.

3.04 ADJUSTING

- A. Adjust door operators, controls, and hardware for smooth and safe operation, for weather-tight closure, and complying with requirements in ANSI/BHMA A156.10.

3.05 CLEANING

- A. Clean glass and aluminum surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish. Comply with requirements in Section 08800 - Glazing for cleaning and maintaining glass.

3.06 MAINTENANCE

- a. Operation and Maintenance Data:
 - 1) Provide Owner's Manual.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for commercial grade aluminum windows of various performance classes.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01454 - Mock-Up Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07920 - Joint Sealants.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CRF: Condensation resistance factor.
 - 2. EPDM: An acronym for ethylene propylene diene M-class rubber used in the manufacture of various seals and membranes.
 - 3. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 4. PVC: An acronym for polyvinyl chloride, a chemical compound used in the manufacture of various plastic items.
 - 5. STC: Sound Transmission Class.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
 - 2. British Thermal Unit or Btu: A measure of energy defined as the amount of heat required to raise the temperature of one pound of water one Fahrenheit degree.



3. Performance Class Number: The actual design pressure in pounds force per square foot (Pascals) used to determine the structural test pressure and water test pressure for the window, and included as part of the window designation system.
 - a. The structural test pressure for the wind load test is equivalent to 150 percent of the design pressure.
 - b. The water-leakage-resistance test pressure is equivalent to 15 percent of the design pressure with 2.86 pounds force per square foot (137Pa) as a minimum for Residential, Commercial, and Heavy-Commercial Grade windows.
4. Low-e: “Low emissivity” coatings are metal or metallic oxide layers deposited on a window or skylight glazing surface primarily to reduce the thermal conductivity by suppressing radiative heat flow.

C. Reference Standards:

1. American Architectural Manufacturer’s Association (AAMA):
 - a. AAMA/WDMA/CSA 101/I.S.2/A440 – Standard Specification for Windows, Doors, and Unit Skylights.
 - b. AAMA 511 - Voluntary Guideline for Forensic Water Leakage Testing of Fenestration Production.
 - c. AAMA 701/702 - Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
 - d. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - e. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. ASTM International (ASTM):
 - a. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - b. ASTM C 509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
 - c. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
 - d. ASTM D 2287 – Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
 - e. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.



- f. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- g. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- h. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- i. ASTM E 413 - Classification for Rating Sound Insulation.
- j. ASTM E 547 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
- k. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- l. ASTM E 783 – Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors [*withdrawn 2002*].
- m. ASTM E 1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 5. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling:
 - 1. Coordinate the aluminum window fabrication schedule with construction progress to avoid delaying the work.

1.04 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Product Data for each type of window required.
 - b. Shop Drawings:
 - 1) Shop Drawings showing the fabrication and installation of each type of window required.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealants.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Aluminum Windows Warranty.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
2. Testing and Inspection Agency:



- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Aluminum Window Installer's Qualifications:
 - a. Engage an experienced installer who has specialized in installing aluminum windows similar in material, design, and extent to those required for this Contract, and with a record of successful in-service performance.
 - b. Submit the aluminum window installer's qualifications to the Program/Project Manager for approval.
2. Aluminum Window Testing Agency's Qualifications:
 - a. To perform the window testing of the Work this Section, employ the services of one or more independent certified testing laboratories having the following qualifications:
 - 1) Each testing laboratory must be independent, certified, and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 699.
 - a) Each testing laboratory must have the experience and capability to satisfactorily perform the reviews, inspections, and testing required of them by this Contract, including but not limited to, inspecting, sampling, and testing proposed materials and systems as required by the Program/Project Manager for compliance with the Contract Documents.
 - b) The testing laboratory must be approved by the Program/Project Manager, and must also be accepted by the Authority Having Jurisdiction (AHJ) and responsible for building inspection.
 - b. Dismissal and replacement of any of these independent certified testing laboratories by the Contractor requires written notice to and the approval from the Program/Project Manager.
 - c. Submit the qualifications and certifications of the proposed testing laboratories to the Program/Project Manager for approval.

C. Mock-Ups:

1. Build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.



- a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. Using the glazing methods to be used for production Work, build mockups having the kinds of glass installed as appropriate to match the glazing systems required under this Section:
2. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 WARRANTY

- A. Extended Correction Period:
 1. Warrant the aluminum window materials and workmanship against failures within the 3-year period after the Date of Substantial Completion:
 2. Submit the written Aluminum Windows Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured aluminum windows that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Alenco Commercial Division, www.alenco.com.
 - b. Capitol Products Corp.
 - c. Custom Window Company, www.customwindow.com.
 - d. DeSCo Windows, www.sescoarc.com.
 - e. EFCO Corporation, www.efcocorp.com.
 - f. International Window Corporation, www.intlwindow.com.
 - g. Peerless Products, Inc., www.peerlessproducts.com.
 - h. Approved equal.
 2. Substitution Limitations:
 - a. The Contract Drawings indicate the size, profiles, dimensional requirements, and aesthetic effects of aluminum windows, and are based on the window types and models indicated.
 - b. Subject to compliance with the requirements indicated in the Contract Documents, other aluminum window manufacturers whose products have equal performance characteristics may be considered.
 3. Product Options:



- a. Source Limitations:
 - 1) Obtain aluminum windows through one source and from a single manufacturer.
- B. ENVISION Requirements:
 - 1. Recycled Content
 - a. Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - 2. Low Emitting Materials – Adhesives and Sealants
 - a. Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168.
 - 3. Low Emitting Materials – Paints and Coatings
 - a. Provide field applied primers whose VOC content is 100g/L or less.
- C. Performance:
 - 1. Provide aluminum windows engineered, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading without failure, as demonstrated by testing the manufacturer's standard window assemblies representing the types, grades, classes, and sizes required for this Contract according to the test methods indicated herein.
 - 2. Air-Infiltration Rate for Operating Units:
 - a. Provide operating window units allowing an air-infiltration rate of not more than 0.37 cubic feet per minute per foot (2.06m³/h/m) of operable sash joint for an inward test pressure of 1.57 pounds force per square foot (75Pa).
 - 3. Air-Infiltration Rate for Fixed Windows:
 - a. Provide fixed window units allowing an air-infiltration rate of not more than 0.15 cubic feet per minute per foot (2.74m³/h/m) of area for an inward test pressure of 1.57 pounds force per square foot (75Pa).
 - 4. Water Penetration:
 - a. Provide window units allowing no water penetration as defined in the test method at an inward test pressure of 15 percent of the design pressure.
 - 5. Condensation Resistance:
 - a. Where window units are indicated to be "thermally improved", provide units showing a condensation resistance factor (CRF) of 45 when



tested for thermal performance in accordance with the requirements specified in AAMA 1503.

6. Thermal Transmittance:
 - a. Provide window units with a maximum U-value of 0.75 British Thermal Unit per square foot·hour·degree Fahrenheit [$3.9\text{W}/(\text{m}^2 \times \text{K})$] at an exterior wind velocity of 15 miles per hour (24km/h), when tested according to AAMA 1503.
7. Thermal Movements:
 - a. Provide aluminum window units that accommodate thermal movements resulting from the following maximum changes (ranges) in ambient and surface temperatures when engineering, fabricating, and installing windows without causing buckling, opening of joints, and overstressing of components, connections, and other detrimental effects:
 - 1) Ambient Temperature Change (Range): 120 degrees Fahrenheit (67 degrees Celsius).
 - 2) Material Surface Temperature Change (Range): 180 degrees Fahrenheit (100 degrees Celsius).
 - b. Base engineering calculations on the actual surface temperatures of materials due to solar heat gain and nighttime sky heat loss.
8. Sound-Insulation Construction:
 - a. Provide window units certified to provide a Sound Transmission Class (STC) rating of at least 40 when tested according to ASTM E 90 and classified according to ASTM E 413.

D. Design Criteria:

1. Design the aluminum windows of the types, grades, classes, and sizes required for this Contract in accordance with the standards indicated herein to withstand normal thermal movement, wind loading, and impact loading without failure.
2. Window Grade and Class:
 - a. Provide fixed windows complying with the requirements for AAMA Grade and Performance Class F-DW-C20.
3. Thermally Improved Construction:
 - a. Design window units with an integral, concealed, low-conductance, thermal barrier, located between exterior materials and window members exposed on the interior, so direct metal-to-metal contact is eliminated.
 - b. Provide thermal-break construction that has been in use for not less than 3 years, has been tested to demonstrate resistance to thermal conductance and condensation, and has been tested to show adequate strength and security of glass retention.



4. Glazing:
 - a. Provide a tempered insulated glazing system with low-e grey glass.
 - b. Provide units that are reglazable without dismantling the sash or ventilator framing.
 - c. Prepare the window sash or ventilators for glazing, except where pre-glazing at the factory is indicated in the Contract Documents.
 - d. Product Data:
 - 1) Submit Product Data for each type of window required to the Program/Project Manager for approval, and include the following information:
 - a) Construction details and fabrication methods.
 - b) Profiles and dimensions of individual components.
 - c) Data on hardware, accessories, and finishes.
 - d) Recommendations for maintaining and cleaning exterior surfaces.
 - e. Shop Drawings:
 - 1) Submit Shop Drawings showing the fabrication and installation of each type of window required to the Program/Project Manager for approval, and include information not fully detailed in the manufacturer's standard Product Data including following:
 - a) Layout and installation details, including anchors.
 - b) Elevations at a scale of 1/4 inch = 1 foot (1:50) and typical window unit elevations at a scale of 3/4 inch = 1 foot (1:20).
 - c) Full-size section details of typical composite members, including reinforcement and stiffeners.
 - d) Location of weep holes.
 - e) Panning details.
 - f) Hardware, including operators.
 - g) Window cleaning provisions.
 - h) Glazing details.

E. Materials:

1. Aluminum Extrusions:
 - a. For main frame and sash members, provide aluminum extrusions of the alloy and temper recommended by the manufacturer for strength, corrosion resistance, and the application of the required finish, but not having an ultimate tensile strength of less than 22,000 psi (150MPa) and not less than 0.062 inch (1.6mm) thick at any location.
2. Fasteners:
 - a. Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be noncorrosive and



- compatible with the aluminum window members, trim, hardware, anchors, and other components of the window units.
- b. Reinforcement:
 - 1) Where fasteners screw anchor into aluminum less than 0.125 inch (3.2mm) thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads or provide standard, noncorrosive, pressed-in, splined grommet nuts.
 - c. Exposed Fasteners:
 - 1) Except where it is unavoidable for the application of hardware, do not use exposed fasteners.
 - 2) For the application of hardware, use fasteners that match the finish of the member or hardware being fastened, as appropriate.
 - 3. Anchors, Clips, and Window Accessories:
 - a. Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel or iron complying with requirements of ASTM B 633.
 - b. Provide anchors, clips, and window accessories of sufficient strength to withstand the design pressure indicated.
 - 4. Compression-Type Glazing Strips and Weatherstripping:
 - a. Unless otherwise indicated, and at the manufacturer's option, provide compressible stripping for glazing and weatherstripping, such as molded EPDM or neoprene gaskets complying with the requirements for Designation 2BC415 to 3BC620 specified in ASTM D 2000, or molded PVC gaskets complying with the requirements specified in ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with the requirements for Grade 4 specified in ASTM C 509.
 - 5. Glazing Stops:
 - a. Provide screw-applied or snap-on glazing stops, coordinated with glass selection and glazing system indicated.
 - b. Finish the glazing stops to match the window units.
 - 6. Sealant:
 - a. For sealants required within fabricated window units, provide the type recommended by the manufacturer for the joint size and movement.
 - b. Provide sealant that remains permanently elastic, non-shrinking, and non-migrating.
 - c. For the selection and installation of sealants, comply with the requirements specified in Section 07920, Joint Sealants.
- F. Shop Fabrication:
- 1. Fabricate aluminum window units in accordance with the standards indicated herein.



- a. Include a complete system for the assembly of components and the anchorage of window units.
2. Weep Holes:
 - a. Provide weep holes and internal passages to conduct infiltrating water to the exterior.
3. Provide water-shed members above side-hinged ventilators and similar lines of natural water penetration.

G. Finishes:

1. Primer Materials:
 - a. Provide the manufacturer's standard corrosion-resistant primer.
2. Finish Materials:
 - a. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in DAF-45.
 - b. High-Performance Organic Coating Finish AA-C12C42R1x:
 - 1) First Chemical Finish: Clean the substrate using inhibited chemicals.
 - 2) Second Chemical Finish: Apply an acid chromate-fluoride-phosphate conversion coating.
 - 3) Organic Coating: Apply the manufacturer's standard 2-coat, thermocured system composed of a specially formulated inhibitive primer and a fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with the requirements specified in AAMA 2605.
 - 4) Color and Gloss: Match the Program/Project Manager's Sample selection.
3. Shop Finishing Methods:
 - a. For recommendations relative to applying and designating finishes, comply with the requirements specified in NAAMM AMP 500.
 - b. Surface Preparation:
 - 1) Perform the manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair the paint bond.
 - 2) Remove mill scale and rust, if present, from the uncoated steel.
 - c. Metal Protection:
 - 1) Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying a sealant or tape recommended by the manufacturer for this purpose.
 - 2) Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.



- d. Priming:
 - 1) Comply with NAAMM AMP 500 for recommendations relative to applying primer.
 - 2) Apply the primer immediately after surface preparation and pretreatment.
- e. High-Performance Organic Coating Finish AA-C12C42R1x:
 - 1) Prepare, pretreat, and apply the high-performance organic coating to exposed metal surfaces in accordance with the coating and resin manufacturer's written instructions.
- f. Appearance of Finished Work:
 - 1) Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples.
 - 2) Noticeable variations in the same piece are not acceptable.
 - 3) Variations in appearance of other components are acceptable if they are within the range of approved Samples, and are assembled or installed to minimize contrast.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. The Testing and Inspection Agency will perform testing to demonstrate compliance with requirements indicated in AAMA/WDMA/CSA 101/I.S.2/A440 for air infiltration, water penetration, and structural performance for the type, grade, and performance class of window units required.
 - a. Design wind velocity at Site is 70 miles per hour (113km/h).
 - b. Where the required design pressure exceeds the minimum for the specified window grade, the requirements of Section 3, "Optional Performance Classes", of AAMA/WDMA/CSA 101/I.S.2/A440, will be complied with for higher than minimum performance class.
 - 2. Air Infiltration Test:
 - a. Test Procedure:
 - 1) Test window units according to the requirements specified in ASTM E 283 for air infiltration.
 - b. Acceptance Criteria:
 - 1) Window units complying with requirements indicated in AAMA/WDMA/CSA 101/I.S.2/A440 for air infiltration have acceptable test results.
 - 3. Water Penetration Test:
 - a. Test Procedure:
 - 1) Test window units according to the requirements specified in ASTM E 547 for water penetration.



- b. Acceptance Criteria:
 - 1) Window units complying with requirements indicated in AAMA/WDMA/CSA 101/I.S.2/A440 for water penetration have acceptable test results.
- 4. Structural Performance Test:
 - a. Test Procedure:
 - 1) Test window units according to the requirements specified in ASTM E 330 for structural performance.
 - b. Acceptance Criteria:
 - 1) Window units complying with requirements indicated in AAMA/WDMA/CSA 101/I.S.2/A440 for structural performance have acceptable test results.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Check window openings by taking field measurements before fabrication of the windows, and show the recorded field measurements on the Shop Drawings
 - 2. Inspect the window openings before installing the windows.
 - a. Verify that the rough or masonry opening is correct, and the sill plate is level.
 - b. Verify that masonry surfaces are visibly dry and free of excess mortar, sand, and other construction debris.
 - c. Verify that Metal surfaces are dry; clean; free of grease, oil, dirt, rust and corrosion, and welding slag; and are without sharp edges or offsets at joints.

3.02 INSTALLATION

- A. Install aluminum windows to withstand the normal thermal movement, wind loading, and impact loading without failure of the types, grades, classes, and sizes indicated for this Contract.
- B. Install sealants, joint fillers, and gaskets after installation of the window units as specified in Section 07920, Joint Sealants.

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:



1. The Testing and Inspection Agency will perform testing with the window manufacturer's representative present to demonstrate compliance with requirements indicated in the test acceptance criteria.
 - a. The Program/Project Manager will select the units to be tested.
 2. Air Infiltration Test:
 - a. Test Procedure:
 - 1) Test window units according to the requirements specified in ASTM E 783.
 - b. Acceptance Criteria:
 - 1) Window units having infiltration less than 1.5 times the amount indicated herein have acceptable test results.
 3. Water Resistance Test:
 - a. Test Procedure:
 - 1) Test window units according to the requirements specified in ASTM E 1105.
 - b. Acceptance Criteria:
 - 1) Window units having no water leakage have acceptable test results.
- B. Non-Conforming Work:
1. Correct windows whose tests do not meet the specified requirements and units having similar deficiencies at no increase in Contract Price.

3.04 ADJUSTING

- A. Adjust the operating sashes and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and a weathertight closure.

3.05 PROTECTION

- A. Provide protection and maintain conditions, in a manner acceptable to the aluminum window manufacturer, that ensure the window units are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.
1	12/20/2017	N/A	Several	Add requirements for ENVISION Sustainability Rating System



SECTION 08705

FINISH HARDWARE



Hardware 24 revised
per RFI 1338

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing finish door hardware.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 07920 - Joint Sealants.
 - 4. Section 08211 - Flush Wood Doors
 - 5. Section 08110 - Steel Doors and Frames.
 - 6. Section 09912 - Painting.
 - 7. Section 09960 - High-Performance Coatings.
 - 8. Section 16130 - Raceway and Boxes.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. ADA: Americans with Disabilities Act.
 - 3. dBA: Decibels, a weighted scale for measuring sound pressure in decibels that uses filters to reduce the contributions of low and high frequency sound.
 - 4. DC: Direct electrical current.
 - 5. SPDT: Single pole, double throw switch.
- B. Definitions:
 - 1. Bit: The wide portion at the end of an ordinary key that moves the bolt.
 - 2. Bitting: One of the indentations on the bit of a key.
 - 3. Butt Hinge or Butt: A hinge with rectangular leaves, usually of the same size, and multiple bearing contacts.
 - 4. Template (for Hardware): A precise detailed layout or pattern for providing the necessary preparation of a door or frame to receive hardware.
- C. Reference Standards:
 - 1. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.3 – American National Standard for Exit Devices.
 - b. ANSI/BHMA A156.4 - American National Standard for Door Controls-Closers.
 - c. ANSI/BHMA A156.16 - American National Standard for Auxiliary Hardware.
 - d. ANSI/BHMA A156.18 – American National Standard for Materials and Finishes.
 - e. BHMA Finish Matchplates.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. Door and Hardware Institute (DHI):
 - a. Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames.



4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. National Fire Protection Association (NFPA):
 - a. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
6. Steel Door Institute (SDI):
 - a. ANSI/SDI A250.6 – Hardware on Standard Steel Doors.
 - b. ANSI/SDI A250.8 - SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
7. U. S. Government:
 - a. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - a) ADA Standards for Accessible Design.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Templates:
 - a. Upon receipt from the Program/Project Manager of the reviewed and approved Finish Hardware Schedule developed by the Contractor, send a copy of the approved schedule and a complete template list for all items requiring template information to the hollow metal manufacturers, aluminum door and frame Suppliers, or any other Supplier requiring this information.
 2. Factory-Installed Hardware:
 - a. If finish door hardware must be installed in the doors at the factory, have the hardware supplier send all hardware items required to the respective door manufacturer so it can be properly installed.
 3. Cylinder and Keying Schedule:
 - a. The Contractor cannot order the airport's unique locks and keys, or install the cylinders.
 - b. Shortly before the Certificate of Occupancy is to be issued, coordinate with the Program/Project Manager to have the Phoenix Aviation Lock Shop furnish and install the airport's unique cylinders, and to have the construction cylinders removed and returned with their keys to the Contractor.
 4. Bitting Schedule:
 - a. Arrange for delivery of the bitting schedule to the City of Phoenix's Locksmith.
 - 1) Properly tag the keys for easy identification, and deliver the keys to the City of Phoenix Locksmith or his representative.
 - b. The Contractor may not have the permanent keys for the Contract's permanent door hardware.
- B. Sequencing:
 1. Take responsibility for arranging the Work and issuing purchase orders to facilitate securing delivery of the hardware and related items, so the Work progresses without delay or interruption.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Butt hinges.
 - 2) Electric hinges.
 - 3) Locks and latches.
 - 4) Keypads.
 - 5) Exit Devices
 - 6) Cylinders.
 - 7) Contacts.
 - 8) Closers.
 - 9) Door coordinators.
 - 10) Manual door bolts.
 - 11) Automatic door bolts.
 - 12) Kickplates.
 - 13) Thresholds.
 - 14) Door bottoms.
 - 15) Door gaskets.
 - 16) Wall type stops.
 - 17) Floor type stops.
 - 18) Local horns.
 - 19) Power supplies.
 - 20) Exit signs.
 - 21) Fasteners.
 - b. Certificates:
 - 1) Finish Hardware Certification.
 - c. Delegated Design Submittals:
 - 1) Finish Hardware Schedule.
- B. Informational Submittals:
- 1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Finish door hardware manufacturer's installation instructions for each type of product specified and provided.
 - b. Manufacturer's Reports:
 - 1) Finish Hardware Supplier Inspection Report.
- C. Closeout Submittals:
- 1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Finish Door Hardware Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
- 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - b. Exit Doors:
 - 1) Provide exit signs at exit doors as required by Section 1011 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.



B. Certifications:

1. Finish Hardware Certification:
 - a. Certify the finish hardware as specified in Paragraph 3.04.A.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Package each item of hardware in original and individual containers, complete with all necessary fastenings, keys, instructions, and templates for spotting mortising tools.
 - a. Mark each container with its item number corresponding to the item number on the finish hardware schedule.
2. Check in and sign for all finish hardware delivered to the Site, and take responsibility for the material delivered thereafter.

B. Storage and Handling Requirements:

1. Provide a room with sufficient space and shelving in which to arrange, securely lockup, and store the finish hardware.
 - a. Lock this room with a lock furnished for this Contract.
2. Provide the following information, corresponding to that shown on the approved finish hardware schedule, on the containers holding keyed locks and cylinders:
 - a. Heading number.
 - b. Door number.
 - c. Hand of door, when required.
 - d. Keying symbol.

1.07 SPECIAL WARRANTY

A. Warrant all hardware for a period of 2 years from the date of acceptance of the Work.

1. Submit a written Finish Door Hardware Warranty to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 FINISH HARDWARE SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - 1) Note that no substitutions will be accepted for many of the finish hardware items when so specified herein.

B. Regulatory Requirements:

1. Phoenix Building Construction Code:



- a. Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 2. Door Closers:
 - a. Provide ADA-compatible door closers in compliance with the ADA Standards for Accessible Design.
- C. Design Criteria:
 1. Design Intent:
 - a. While the components listed herein are intended to cover all doors and establish a type and standard of quality, where the size and shape of members to be equipped with hardware prevents or makes unsuitable the use of the exact types specified, provide suitable types having as nearly as practicable the same operation, function, style, and quality as that listed.
 2. Finish Hardware Schedule:
 - a. After examining the Specifications and Contract Drawings, develop a Finish Hardware Schedule identifying all required finish hardware for all openings, whether listed or not; and prior to ordering the required hardware, submit the Finish Hardware Schedule to the Program/Project Manager for approval.
 - 1) Include hardware of sizes adequate for the service to which the individual items of hardware will be subjected in the course of normal usage.
 - 2) Indicate the following information in the Finish Hardware Schedule:
 - a) Door number and location.
 - b) Quantity.
 - c) Manufacturer's number and item number.
 - d) Size, finish, and all other pertinent information necessary for manufacturing and proper installation of the item.
 - e) Complete keying instructions and symbols.
 - b. If there are any omissions in the hardware groups for regular doors, notify the Program/Project Manager for direction.
 - c. Anticipate allowing at least 2 weeks for the Program/Project Manager to review and evaluate the Finish Hardware Schedule before being able to consider ordering the hardware from the Supplier.
 3. Exit Doors:
 - a. Provide exit doors designed to be operable from the inside without the use of keys or any special knowledge or effort during business hours
 - 1) Do not provide deadbolts, slide bolts, or similar devices on exit doors that may interfere with the intended operation of the doors.
 - 2) Provide signage as required by Section 1008.1.8, Door Operations, in the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 4. Product Data:
 - a. Submit Product Data for each type of product specified and provided.
 - b. Where cylindrical locks are to be installed in hollow metal doors, have the door manufacturer provide lock reinforcing in the door when the door is manufactured.
- D. Components:
 1. Butt Hinges:
 - a. For exterior out-swinging doors and out-swinging corridor doors having locks, provide butt hinges having a pin that is non-removable when the door is closed.
 - 1) For 1-3/4-inch thick doors up to 40 inches wide, provide 4-1/2-inch butt hinges.



- 2) For 1-3/4-inch thick doors from 41 inches to 48 inches wide, provide 5-inch butt hinges.
 - b. For interior doors, provide butt hinges having a non-rising pin.
 - 1) For 1-3/4-inch thick doors up to 40 inches wide, provide 4-1/2-inch butt hinges.
 - 2) For 1-3/4-inch thick doors from 41 inches to 48 inches wide, provide 5-inch butt hinges.
 - c. Size butt hinges wide enough to clear all trim.
 - d. For doors with closers, provide ball bearing butt hinges.
 - e. Finish:
 - 1) Provide a BHMA 626 satin chromium plated (US26D) as specified in ANSI/BHMA A156.18 and the BHMA Finish Matchplates.
 - f. Manufacturers:
 - 1) The Stanley Works, Model CB179, www.stanleyhardware.com.
 - 2) McKinney Hinge, Division of Assa Abloy, www.mckinneyhinge.com.
 - 3) Hager Companies, www.hagerco.com.
 - 4) Approved equal.
2. Electrical Power Transfer:
 - a. Provide a two-wire electrical power transfer device, UL-listed for use on fire doors under UL Category GVUX, that is capable of transferring electrical power from a door frame to the edge off a swinging door.
 - 1) Provide wiring that is at least 18AWG, and capable of carrying up to 2 Amperes at 24 Volts DC with a maximum surge of 16 Amperes.
 - 2) Provide units that are completely concealed when the door is in the closed position.
 - b. Manufacturers:
 - 1) Von Duprin, Model EPT-10, <http://www.vonduprin.com>.
 - 2) Sargent, IN Series PoE compatible Ethernet Hinge.
 - 3) Approved equal.
3. Pivot Sets:
 - a. Provide offset type pivots complying with the requirements specified in A156.4, and designed for the door weight.
 - b. Manufacturers:
 - 1) Lockmart, ABH Door Hardware, Model ABH 0195, <http://www.abhdoorhardware.com>ANSI.
 - 2) Approved equal.
4. Locks and Latches:
 - a. Provide locksets manufactured by one manufacturer.
 - b. Finish:
 - 1) Provide a BHMA 626 satin chromium plated (US26D) as specified in ANSI/BHMA A156.18 and the BHMA Finish Matchplates.
 - c. Manufacturers:
 - 1) Sargent, Manufacturing Company, Division of Assa Abloy, DG2-Series, www.sargentlock.com.
 - a) For storeroom/closet doors, provide Model DG2-6300.
 - b) For entry/office doors.
 - c) For rated paired openings, provide 3/4-inch latch bolts.
 - 2) No substitutions will be accepted.
5. Keypads:
 - a. Provide keypads complying with the requirements specified by the Phoenix Aviation Lock Shop.



- b. Finish:
 - 1) Provide a BHMA 626 satin chromium plated (US26D) as specified in BHMA A156.18 and the BHMA Finish Matchplates.
- c. Manufacturers:
 - 1) Alarm Lock, Trilogy™, Model PDL3000IC/26D-R Trilogy Prox Digital Lock, www.alarmlock.com
 - 2) No substitutions will be accepted.
- 6. Intelligent IP-Enabled Access Control
 - a. Provide the following for the Intelligent IP-Enabled Access Control:
 - 1) Card Lock: DG264 28 IN220-10G77 BIPS B LL
 - 2) Concealed PoE Power Transfer: Securitron, CEPT-C5E.
 - 3) PoE Frame Wiring Harness: McKinney, PoE-C1500P with Custom Lengths
 - 4) PoE Wiring Harness: McKinney, PoE-CxxxRJ.
 - 5) IN-Series Cylindrical Lock Functions:
 - a) IN220 10 Line cylindrical locks UL certified and listed as part of an approved assembly.
 - b) Low battery request-to-exit (REX) and tamper signaling standard
 - c) Door Position Switch (DPS, P/N 52-5373) supplied with IN220 cylindrical locks
 - 6) Rose: Metal trim.
 - 7) Card Reader: Black reader, black trim.
 - 8) Lever: L-Style, 26D Satin Chrome (ANSI 626).
 - 9) Strike: 4-7/8" Strike #808. Lip Length 1-1/4.
 - 10) Degree Cylinders: DG2-64, Degree Level 2 Removable construction keyed LFIC.
- 7. Exit Devices:
 - a. Provide panic exit devices manufactured by one manufacturer.
 - b. Finish:
 - 1) Provide a BHMA 626 Satin chromium plated (US26D) as specified in ANSI/BHMA A156.18 and the BHMA Finish Matchplates.
 - c. Manufacturers:
 - 1) Sargent, Manufacturing Company, Division of Assa Abloy, Sargent 80 Series, www.sargentlock.com.
 - 2) Approved equal.
- 8. Lock Cylinders:
 - a. The hardware will need to be construction keyed with construction cylinders.
- 9. Door Position Switches:
 - a. Provide door position switches designed for monitoring applications for hollow metal doors and frames.
 - b. Provide door position switches designed operation using 0.3 Amperes at 30 Volts DC.
 - a. Manufacturers:
 - 1) Ingersoll Rand Company, Schlage Locknetics, 679-05HM, <http://www.locknetics.com>.
 - 2) Assa Abloy, Sargent, 52-5373 Supplied with IN220 cylindrical locks.
 - 3) Approved equal.
- 10. Keys and Keying:
 - a. Provide construction keys for the locks in accordance with factory pinning depth specifications and tolerances to ensure that all cylinders will operate smoothly when the keys are cut by the code machine.
 - b. Provide nickel silver construction keys with blank bows.



- c. Provide construction bitting of random depth cuts.
 - 1) Do not provide "0" or "1" bitted keying.
- 11. Closers:
 - a. Provide overhead; surface applied, parallel arm mounting ADA-compliant closers.
 - 1) Verify that the door has the proper door reinforcement/backing to support the operation of the closer provided.
 - b. Finish:
 - 1) Provide a sprayed finish to match the adjacent hardware.
 - c. Manufacturers:
 - 1) Sargent, Manufacturing Company, Division of Assa Abloy, 351Series, www.sargentlock.com.
 - 2) No substitutions will be accepted.
- 12. Concealed Closer:
 - a. Provide concealed door closers complying with the accessibility requirements of the ADA Standards for Accessible Design, and having the manufacturer's standard arm, track, mounting/finish plate, and mounting screws.
 - b. Provide concealed door closers complying with the requirements for Grade 1 door closers specified in ANSI/BHMA A156.4.
 - a. Manufacturers:
 - 1) LCN, Division of Ingersoll Rand, 2030 Series, <http://www.lcnclosers.com>.
 - 2) Approved equal.
- 13. Door Coordinators:
 - a. Provide steel door coordinators complying with the requirements specified in ANSI/BHMA A156.3, capable of holding the active door leaf open while the inactive door leaf closes, and consisting of the coordinator operating mechanism assembly, filler plates, strike plates, and mounting hardware.
 - 1) Provide door coordinators allowing door closing speeds to be adjusted.
 - b. Finish:
 - 1) Provide door coordinators having a USP, black prime coat, finish.
 - c. Manufacturers:
 - 1) Hager Companies, Model 279D with a filler piece, www.hagerco.com.
 - 2) Approved equal.
- 14. Door Bolts:
 - a. Manual Door Bolts:
 - 1) Provide Grade 1 manual flush door bolts complying with the requirements specified in ANSI/BHMA A156.16, and designed for mortising into door edge with dustproof strike.
 - 2) Manufacturers:
 - a) Hager Companies, Model 281D (install top only), www.hagerco.com
 - b) Approved equal.
 - b. Automatic Door Bolts:
 - 1) Provide stainless steel/brass automatic flush bolts, including the bolting mechanism assembly, strike plates, necessary shims, and mounting hardware complying with the requirements specified in ANSI/BHMA A156.3, and designed for two point latching of metal doors.
 - 1) Manufacturers:
 - a) Hager Companies, Model 292D, www.hagerco.com
 - b) Approved equal.
- 15. Kickplates:



- a. Provide UL-listed, stainless steel kickplates, 0.062 inch (1.6mm) thick, 12 inches high, beveled on 3 sides, and having counter sunk holes for screw mounting.
 - b. Finish:
 - 1) Provide kickplates having a US32D finish.
 - c. Manufacturers:
 - 1) Hager Companies, Model 223S, www.hagerco.com
 - 2) Approved equal.
16. Thresholds:
- a. Provide aluminum saddle type thresholds as indicated in the hardware groups.
 - b. Length: 36 inches, or 72 inches as required for a pair of doors
 - c. Finish:
 - 1) Provide a mill finish on the aluminum.
 - d. Manufacturers:
 - 1) Pemko, Division of Assa Abloy, Model 151A, 168A, 227A, www.pemko.com.
 - 2) Approved equal.
17. Door Bottoms:
- a. Provide surface mounted, exterior door style door bottoms with end plates to finish the ends.
 - b. Length: 36 inches.
 - c. Finish: Clear anodized aluminum.
 - d. Manufacturer:
 - 1) Pemko, Division of Assa Abloy, Model 430CRL or 4301_NBL as indicated on schedule, www.pemko.com.
 - 2) Approved equal.
18. Door Gasketing:
- a. Provide a compression bulb type gasket having an adhesive backing.
 - b. Color: Black.
 - c. Manufacturers:
 - 1) Pemko, a Division of Assa Abloy, Model S88BL (S88 Silicone Seal™), www.pemko.com.
 - 2) Approved equal.
19. Stops:
- a. Wall Type Stops:
 - 1) Provide concave, rimless rubber wall bumpers
 - a) Inside Diameter: 1-1/4 inches.
 - b) Outside Diameter: 1-7/8 inches.
 - c) Projection: 11/16 inch.
 - 2) Mounting Hardware:
 - a) Provide toggle bolts and wall sleeves.
 - 3) Manufacturers:
 - a) Triangle Brass Manufacturing Company, Trimco Model No.1271TB, www.trimcobbw.com.
 - b) Approved equal.
 - b. Floor Type Stops:
 - 1) Provide cast floor stops.
 - a) Base: 1-3/8 inches by 2-3/4 inches.
 - b) Height: 2-7/8 inches.
 - 2) Finish:
 - a) Provide floor stops having a BHMA 626 satin chromium plated (US26D) as specified in BHMA A156.18 and the BHMA Finish Matchplates.
 - 3) Mounting Hardware:



- a) Provide wood screws or machine screws and anchors as applicable.
- 4) Manufacturers:
 - a) Triangle Brass Manufacturing Company, Trimco Model No. 1233, www.trimcobbw.com.
 - b) Approved equal.
- 20. Power Supplies:
 - a. Provide power supplies designed for electromagnetic locks and electric strikes on single door applications, having field selectable power outputs of either 1 Ampere at 24 Volts DC or 2 Amperes at 12 Volts DC.
 - b. Enclosure:
 - 1) Provide power supply enclosures fabricated from at least 19 gauge steel, and having a hinged keylock cover and at least six 1/2-inch diameter knockouts.
 - 2) Provide pre-drilled holes for mounting screws or bolts.
 - c. Power Input:
 - 1) Provide power supplies designed to operate on 0.6 Amperes, 120 Volts AC, 60 Hertz input power.
 - 2) Provide a 2.5 Ampere slow-blow fuse to protect the unit.
 - d. Manufacturers:
 - 1) Securitron, Division of Assa Abloy, Model BPS 12/24-1, <http://www.securitron.com/en/site/securitron>.
 - 2) Approved equal.
- E. Fabrication:
 - 1. Metal Door and Jamb Hardware:
 - a. Fabricate the hardware for metal doors and jambs according to the templates for the hardware on the template list and approved Finish Hardware Schedule sent to the manufacturer.
 - b. Secure the hardware for metal doors and jambs to them using machine screws.

2.02 ACCESSORIES

- A. Exit Signs:
 - 1. Provide exit signs for exit doors as required by Section 1011 of the ICC International Building Code (IBC) as Amended by the City of Phoenix.
- B. Fasteners:
 - 1. With the finish hardware, provide screws, bolts, and/or other fasteners of the size, type, and quantity suitable and necessary for anchoring the hardware in position for heavy use and long life.
 - 2. Provide fasteners harmonized with the hardware material and finish.
 - 3. Where necessary, provide expansion shields, hex bolts, toggle bolts, and other approved anchors for the fastenings as recommended by the fastening manufacturer for the material to which it is applied.
 - 4. For fastening hardware to concrete, provide machine screws and tamp-ins.
 - 5. For closers on wood or mineral core doors, provide hex bolt type fasteners.



PART 3 EXECUTION

3.01 PREPARATION

A. Surface Preparation:

1. Onsite door preparation is restricted by NFPA 80 to that required for surface-applied door hardware, function holes for mortise locks, holes for labeled viewers, undercutting of doors, and protection plates.
2. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate the removal, storage, and reinstallation of surface protective trim units with the finishing work specified in Section 09912, Painting, and/or Section 09960, High-Performance Coatings.
 - a. Do not install surface-mounted items until finishes have been completed on substrates involved.

3.02 INSTALLATION

A. Install each door hardware item in compliance with the manufacturer's written instructions.

1. For each type of product specified and provided, submit the finish door hardware manufacturer's installation instructions to the Program/Project Manager for information.
2. Set units level, plumb, and true to line and location.
3. Adjust and reinforce the attachment substrates as necessary for proper installation and operation of the door hardware.
4. Space fasteners and anchors according to industry standards.
 - a. Drill and countersink units that are not factory prepared for anchorage fasteners.

B. Steel Doors and Frames:

1. For surface applied door hardware for steel doors and frames, drill and tap the doors and frames in accordance with the requirements of ANSI/SDI A250.6.

C. Wood Doors:

1. For wood doors, install finish hardware in accordance with the requirements of DHI-WDHS-5.

D. Mounting Heights:

1. Mount door hardware units at heights complying with the following unless otherwise indicated on the Contract Drawings or required to comply with governing regulations:
 - a. For standard steel doors and frames, comply with the mounting height requirements specified in ANSI/SDI A250.8.
 - b. For wood doors, comply with the mounting height requirements specified in DHI-WDHS-3.

E. Hinges:

1. Install the types and quantities of hinges indicated in the door hardware schedule, but not fewer than the number recommended by the manufacturer for the application indicated, or one hinge for every 30 inches (750mm) of door height, whichever is more stringent, unless other equivalent means of support for the door, such as spring hinges or pivots, are provided.



- F. Door Power Transfers:
 - 1. Install concealed power transfers.
 - 2. Run the number and size of conductors required between the door and wall.
- G. Lock Cylinders:
 - 1. Install construction cores to secure the building and other areas during the construction period.
 - a. Shortly before the Certificate of Occupancy is to be issued, the City of Phoenix Aviation Department's Locksmith will complete the door hardware keying.
- H. Thresholds:
 - 1. Set the thresholds for exterior doors, and for other doors indicated in the Finish Hardware Schedule or on the Contract Drawings to have thresholds placed in sealant, in a full bed of sealant complying with the requirements specified in Section 07920, Joint Sealants.
- I. Door Bottoms:
 - 1. Apply bottoms to the bottoms of the doors, to form a seal with the threshold when the door is closed.
- J. Perimeter Gasketing:
 - 1. Apply perimeter gasketing to the head and jamb, forming a seal between the door and frame.
- K. Meeting Stile Gasketing:
 - 1. Fasten gasketing to meeting stiles, to form a seal when the doors are closed.
- L. Stops:
 - 1. Unless wall or other type stops are indicated in Finish Hardware Schedule, on the Contract Drawings provide floor stops for doors.
 - 2. Do not mount floor stops where they will impede traffic.

3.03 REPAIR/RESTORATION

- A. Correct defects in materials and/or workmanship occurring during the warranty period at no increase in the Contract Price.

3.04 SITE QUALITY CONTROL

- A. Manufacturer Services:
 - 1. Require the finish hardware Supplier to visually inspect the installation of the finish hardware at the completion of the hardware installations.
 - a. Have the finish hardware supplier note all discrepancies or errors in the installation and operation of the hardware, and submit a Finish Hardware Supplier Inspection Report documenting his findings to the Program/Project Manager.
 - b. Upon completion of the inspection but before the final inspection, have the finish hardware Supplier submit a Finish Hardware Certification to the Program/Project Manager certifying that all hardware is properly installed according to the manufacturer's printed instructions, and is working properly.



- 1) Submit the letter of certification to the Program/Project Manager as soon as possible after installation of all hardware.

3.05 ADJUSTING

- A. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit.
 1. Replace units that cannot be adjusted to operate as intended.
 2. Adjust the spacing of the door contacts for proper operation.
- B. Adjust door control devices to compensate for the final operation of heating and ventilating equipment, and to comply with referenced accessibility requirements.

3.06 CLOSEOUT ACTIVITIES

- A. Tag all keys, and turn them over to the Phoenix Sky Harbor International Airport upon completion of the Work.

3.07 PROTECTION

- A. Protect finish door hardware from damage, both prior to and after installation.

3.08 ATTACHMENTS – FINISH HARDWARE SCHEDULE

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
 1. Schedule 08705-1 Finish Hardware Schedule.



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group1		
Hinges	3	Stanley CB179
Lockset	1	Sargent DG264 28 10G04 LL
Removable Core	1	Sargent DG2-6300
Contacts	1	Locknetics 679-05HM
Closers	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Threshold		Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 2 RFI 2578 RCC BOH Gates and Strobe Conflict		
Hinges	3	Stanley CB179
Exit Devices	1	Sargent DG264 12 8813 F ETL
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB
Hardware Group 3		
Hinges	3	Stanley CB179
Lockset	1	Sargent DG264 28 10G04 LL
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Wall Stop	1	Trimco 1271TB

RFI
2800 RCC Level 4 Shaft
Room Threshold



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 4		
Hinges	3	Stanley CB179
Card Lock	1	DG264 28 IN220-10G77 BIPS B LL
Concealed PoE Power Transfer	1	Securitron CEPT-C5E
PoE Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
PoE Wiring Harness	1	McKinney PoE-CxxRJ Length as required
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" high
Threshold	1	Pemko 151A
Wall Stop	1	Trimco 1271TB
Hardware Group 5		
Hinges	4	Stanley CB179
Exit Device	1	12-8804 ETL
Cylinder	1	10-63-41
Electric Strike	1	HES 9500
Contacts	2	Locknetics 679-05HM
Concealed Closer	1	LCN 2030 Series
Threshold	1	Pemko 272A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB
Power Supply	1	Securitron BPS 12/24-1
Card Readers	2	By Others (ACAMS Slimline)
Note: Security Monitor - Card Reader both sides (2)		
Contacts required for security		



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 6		
Hinges	6	Stanley CB179
Lockset	1	41-60-10G04 LL
Removable Core	1	Sargent 10-6300
Electric Strike	1	HES 1006 J
Contacts	2	Locknetics 679-05HM
Closer	2	Sargent 351
Coordinator	1	Hager297D with filler piece
Automatic Door Bolts	1	Hager 292D
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stops	2	Trimco 1271TB
Power Supply	1	Securitron BPS 12/24-1
Card Reader	1	By Others



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 7		
Hinges	6	Stanley CB179
Lockset	1	Sargent DG264 28 41 10G04 LL
Automatic Flushbolt	2	Hager 292D
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Coordinator	1	Hager 297D with filler piece
Dustproof Strike	2	Rockwood 570
Kickplate	2	Hager 223S 12" high
Gasketing	2	Pemko S88BL
Astragal	2	Pemko 303AV
Wall Stop	2	Trimco 1271TB



Hardware Group 8		
Hinges	6	Stanley CB179
Card Reader Exit Device	1	Sargent DG264 55 12 IN220 8977 BIPS B ETL
Auto Flush Bolt	1	Hager 292D
Removable Core	1	Sargent DG2-6300
PoE Frame Wiring Harness	1	McKinney CxxxxP Length as required
PoE Door Wiring Harness	1	McKinney CxxxRJ Length as required
Closer	2	Sargent 351 CPS
Coordinator	1	Hager 297D with filler plates
Mounting Brackets	2	Hager 297M
Position Switch	1	Sargent 52-5373 (at inactive leaf)
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Astragal	2	Pemko 303AV
Power Transfer	1	McKinney CEPT-CSE
Dustproof Strike	1	Rockwood 570



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 9		
Hinges	8	Stanley CB179
Card Lock	2	DG264 28 IN220-10G77 BIPS B LL
Concealed PoE Power Transfer	1	Securitron CEPT-C5E
PoE Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
PoE Wiring Harness	1	McKinney PoE-CxxRJ Length as required
Removable Core	1	Sargent DG2-6300
Closer	2	Sargent 351
Coordinator	1	Hager 297D with filler piece
Mounting Brackets	2	Hager 297M
Position Switch	2	Locknetics 675-09HM
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Astragal	1	Pemko 303AV
Wall Stops	2	Trimco 1271TB
Auto Flush Bolt	1	Hager 292D
Dustproof Strike	1	Rockwood 570



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 10		
Hinges	6	Stanley CB179
Lockset	1	60-10G04 LL
Removable Core	1	Sargent 10-6300
Closer	2	Sargent 351
Door Bolt	2	Hager 281D
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Wall Stop	2	Trimco 1271TB
Hardware Group 11 (Blind Door)		
Pivot Set	1	ABH 0195
Inter. Pivots	2	ABH 019
Mortise Deadlock	1	Accurate Lock 9503 x 5 inch backset x GF1106 1/2
Cylinder Extender	1*	Southern Steel - Key Cylinder Extender (KSE)
Cylinder	1	10-63-34
Closer	1	Sargent 351
Door Pull	1	Trimco 1102S
Floor Stop / Holder	1	Trimco 1263
Note: Install Deadlock 48 inches C/L - Coordinate installation location		
* Cylinder extender approximately 6 inches long inserted through metal veneer to lock - Coordinate conditions		



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 12		
Hinges	6	Stanley CB179
Door Bolt	2	Hager 281D
Latchset	1	10U15 LL
Silencer	2	Trimco 1229A
Hardware Group 13		
Hinges	3	Stanley CB179
Lockset	1	41-60-10G04 LL
Removable Core	1	Sargent 10-6300
Electric Strike	1	HES 1006 J
Contacts	1	Locknetics 679-05HM
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB
Power Supply	1	Securitron BPS 12/24-1
Hardware Group 14		
Hinges	6	Stanley CB179
Lockset	1	41-60-10G04 LL
Removable Core	1	Sargent 10-6300
Coordinator	1	Hager 297D with filler piece
Automatic Door Bolts	2	Hager 281D
Kickplate	2	Hager 223S 12" high



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 15		
Hinges	3	Stanley CB179
Office Lockset	1	60-28-10G05 x LL26D
Removable Core	1	Sargent 10-6300
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Wall Stop	1	Trimco 1271TB
Hardware Group 16		
Hinges	8	Stanley CB179
Removable Core	1	Sargent 10-6300
Closer	2	Sargent 351
Coordinator	1	Hager 297D with filler piece
Automatic Door Bolts	1	Hager 292D
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stops	2	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 17		
Hinges	4	Stanley CB179
Lockset	1	Sargent-41-60-10G04 LL
Removable Core	1	Sargent 10-6300
Electric Strike	1	HES 1006 J
Contacts	2	Locknetics 679-05HM
Closer	1	Sargent 351
Sweep	1	Pemko 4301_NBL
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Power Supply	1	Securitron BPS 12/24-1
Card Readers	2	By Others
Note Security Monitor – Card Reader both sides (2)		
Contacts required for security		
Hardware Group 18		
Hinges	8	Stanley CB179
Mechanical Lockset	1	Trilogy ETPDLS1G/26DS88
Exit Device	1	Sargent 8888F32D
Flush Bolts	1	Hager 281D top only
Astragal	1	Pemko 3572
Closer	1	Sargent 351
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Sweep	1	Pemko 4301_NBL



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 19		
Hinges	3	Stanley CB179
Lockset	1	Sargent-41-60-10G04 LL
Removable Core	1	Sargent 10-6300
Closer	1	Sargent 351
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB
Hardware Group 20		
Hinges	3	Stanley CB179
Lockset	1	Sargent 41-60-10G04LL
Closer	1	Sargent 351
Threshold	1	Pemko 151A
Sweep	1	Pemko 4301_NBL
Gasketing	1 Set	Pemko S88BL
Hardware Group 21		
Hinges	4	Stanley CB179
Lockset	1	Trilogy PDL3000-IC-R
Closer	1	Sargent 351
Threshold	1	Pemko 151A
Sweep	1	Pemko 4301_NBL
Gasketing	1 Set	Pemko S88BL



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 22		
Hinges	8	Stanley CB179
Exit Device	1	12-8804ETL
Removable Core	1	Sargent 10-63-41
Electric Strike	1	HES 9500
Contacts	2	Locknetics 679-05HM
Closer	1	Sargent 351
Sweep	1	Pemko 4301_NBL
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Power Supply	1	Securitron BPS 12/24-1
Card Readers	2	By Others
Note Security Monitor – Card Reader both sides (2)		
Contacts required for security		
Hardware Group 23		
Hinges	4	Stanley CB179
Mechanical Lockset	1	Trilogy PDL3000 - IC - R
Removable Core	1	Sargent 10-6300
Contacts	1	Locknetics 679-05HM
Exit Device	1	Sargent 8888F32D
Kickplate	1	Hager 223S 12" high
Gasketing	1 Set	Pemko S88BL
Wall Stops	1	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 24		
Hinges	4	Stanley CB179 168 (Heavy Weight Hinge)
Panic Hardware	1	Sargent DG264 8804 F ETL
Cylinder	1	Sargent DG2-6300
Surface Closer/ Stop	1	Sargent 351 CPS
Gasketing	1	Pemko S88BL
door contacts removed per RFI 1338		
Hardware Group 25		
Hinges	3	Stanley CB179
Storeroom Lockset	1	DG260-10G04 LL
Removable Core	1	Sargent DG2 6300
Electric Strike	1	HES 7501-24
Contacts	1	Locknetics 679-05HM
Closers	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB (interior doors only)
Power Supply	1	Securitron BPS 12/24-1
Card Readers	1	By Others



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 26		
Hinges	3	Stanley CB179
Storeroom Lockset	1	DG60-10G04 LL
Removable Core	1	Sargent DG2 6300
Electric Strike	1	HES 7501-24
Contacts	1	Locknetics 679-05HM
Closers	1	Sargent 351 CPS (exterior doors only)
Kickplate	1	Hager 223S 12" High
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko 303AS
Door Sweep	1	Pemko 315CN
Power Supply	1	Securitron BPS 12/24-1
Card Readers	1	By Others
Hardware Group 27		
Hinges	3	Stanley CB179
Exit Devices	1	12-8813xETL
Cylinder	1	10-63-41
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 28		
Hinges	3	Stanley CB179
Card Lock	1	Sargent DG264 28 IN220-10G77 BIPS B LL
Concealed PoE Power Transfer	1	Securitron CEPT-C5E
PoE Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
PoE Wiring Harness	1	McKinney PoE-CxxxRJ Length as required
Removable Core	1	Sargent DG2-6300
Closers	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Threshold		Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 29		
Hinges	3	Stanley CB179
Card Reader Exit Device	1	Sargent DG264 12* IN220 887 ETL
Power Transfer	1	McKinney CEPT-D5E
Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
Door Wiring Harness	1	McKinney PoE-CxxxRJ Length as required
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Wall Stop	1	Trimco 1271TB
*For the Card Reader Exit Device, "12" required for fire rated openings		
Hardware Group 30		
Hinges	3	Stanley CB179
Card Lock	1	Sargent DG264 28 IN220-10G77 BIPS B LL
Concealed PoE Power Transfer	1	Securitron CEPT-C5E
PoE Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
PoE Wiring Harness	1	McKinney PoE-CxxxRJ Length as required
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Kickplate	1	Hager 223S 12" High
Wall Stop	1	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 31		
Hinges	6	Stanley CB179
Card Lock	1	Sargent DG264 28 IN220-10G77 BIPS B LL
Concealed PoE Power Transfer	1	Securitron CEPT-C5E
PoE Frame Wiring Harness	1	McKinney PoE-CxxxxP Length as required
PoE Wiring Harness	1	McKinney PoE-CxxxRJ Length as required
Automatic Flushbolt	2	Hager 293D
Removable Core	1	Sargent DG2-6300
Closer	1	Sargent 351
Coordinator	1	Hager 297D with filler piece
Dustproof Strike	2	Rockwood 570
Kickplate	2	Hager 223S 12" high
Gasketing	2	Pemko S88BL
Astragal	2	Pemko 303AV
Wall Stop	2	Trimco 1271TB



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 32		
Hinges	8	Stanley CB179
Storeroom Lock	1	DG264 28 10G04 LL
Concealed Power Transfer	1	Securitron EL-CEPT
Frame Wiring Harness	1	McKinney QC-CxxxP Length as required
Wiring Harness	1	McKinney QC-CxxP Length as required
Removable Core	1	Sargent DG2-6300
Closer	2	Sargent 351
Coordinator	1	Hager 297D with filler piece
Mounting Brackets	2	Hager 297M
Electric Strike	1	HES 1006
Position Switch	2	Locknetics 675-09HM
Kickplate	2	Hager 223S 12" high
Threshold	1	Pemko 151A
Gasketing	1 Set	Pemko S88BL
Astragal	1	Pemko 303AV
Wall Stops	2	Trimco 1271TB
Auto Flush Bolt	1	Hager 292D
Dustproof Strike	1	Rockwood 570



Schedule 08705-1 Finish Hardware Schedule		
Hardware Groups and Items	Quantity	Manufacturer and Model
Hardware Group 33		
Hinges	4	Stanley CB179
Recessed Exit Device	1	Stanley 170061
Electric Strike	1	HES 9500
Position Switch/ Contacts	1	Locknetics 679-05HM
Door Operator	1	Stanley Magic-Force Swing Door Operator
Threshold	1	Pemko 272A
Gasketing	1 Set	Pemko S88BL
Floor Stop	1	Trimco 7280
Actuator	2	Stanley Mullion Mount Push Plate (each side of door)
Power Supply	1	Securitron BPS 12/24-1
Notes: 1. Door Operator shall have an Electrified Locking Function (Electric Lock Solenoid located within the header) to Communicate with the Fire Control System. 2. 4" Muntin Bar on Door Panel		



END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	09/07/2018	N/A	3.08.A.1	Add Hardware Set 24
2	02/06/2019	N/A	08705-1	Add Hardware Sets 25 & 26
3	04/29/2019	N/A	08705-1	Add Hardware Set 27
4	05/28/2019	N/A	2.01.D.2, 4, 6, 7 & 8, 08705-1	Add new hardware information and revise Hardware Sets 1, 2, 3, 4, 7, 8, 9; add Hardware Sets 28-32
5	06/05/2019	N/A	08705-1	Typ-o on Hardware Set 32. Concealed Power Transfer; not PoE.
6	07/16/2019	N/A	08705-1	Edit Hardware Set 24
7	08/05/2019	N/A	08705-1	Edit Hardware Set 24



SECTION 08716

AUTOMATIC DOOR OPERATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Low-energy door operators for swinging doors.
 - 2. Power-assist door operators for swinging doors.
- B. Related Requirements:
 - 1. Section 08415 "Aluminum Entrances and Storefronts" for exterior aluminum entrance swinging doors and frames.
 - 2. Section 08460 "Automatic Entrance Doors" for bi-parting and telescoping, sliding automatic entrances packaged with automatic door operators.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADA: Americans with Disabilities Act.
 - 2. ADAAG: Americans with Disabilities Act Accessibility Guidelines.
 - 3. ANSI: American National Standards Institute.
 - 4. CRF: Condensation resistance factor.
 - 5. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called "credits"—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
 - 3. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.



C. Reference Standards:

1. Aluminum Association (AA):
 - a. DAF-45 – Designation System for Aluminum Finishes.
2. American Architectural Manufacturer's Association (AAMA):
 - a. AAMA 511 - Voluntary Guideline for Forensic Water Leakage Testing of Fenestration Production.
 - b. AAMA 701/702 - Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals.
 - c. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - d. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
3. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - e. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - f. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - g. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - h. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
 - i. ASTM B 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire [Metric].



- j. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- k. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- l. ASTM B 429/B 429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- m. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
- n. ASTM D 2287 – Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
- o. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- p. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- q. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- r. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- 5. American Welding Society (AWS):
 - a. AWS A5.10/A5.10M – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
 - b. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
- 6. Builders Hardware Manufacturers Association (BHMA):
 - a. ANSI/BHMA A156.1 –Butts and Hinges.
 - b. ANSI/BHMA A156.4 –Door Controls – Closers.
 - c. ANSI/BHMA A156.5 – Auxiliary Locks and Associated Products.
 - d. ANSI/BHMA A156.16 –Auxiliary Hardware.
 - e. ANSI/BHMA A156.19 – Power Assist and Low Energy Power Operated Doors
- 7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 8. Glass Association of North America (GANA):
 - a. GANA Glazing Manual.
- 9. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.



10. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule #1168 – Adhesive and Sealant Applications.
11. Underwriter's Laboratories, Inc. (UL):
 - a. UL 305 - Standard for Panic Hardware.
12. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)], <http://www.access-board.gov/adaag/html/adaag.htm>.
 - b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - c. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Templates:
 - a. Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.
 2. Hardware:
 - a. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
 3. Electrical System Rough-in:
 - a. Coordinate layout and installation of automatic door operators with connections to power supplies and access-control system
- B. Scheduling:
 1. Coordinate the automatic door operator fabrication schedule with construction progress to avoid delaying the work.
- C. Maintenance Service:
 1. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of automatic door operator Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.



- a. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
 - b. Perform maintenance, including emergency callback service, during normal working hours.
 - c. Include 24-hour-per-day, 7-day-per-week, emergency callback service.
2. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data: For each type of product.
 - 1) Automatic Door Operators.
 - 2) Hardware coordinated with Door and Operator.
 - 3) Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators.
 - 4) Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories
 - b. Shop Drawings:
 - 1) Automatic Door Operators.
 - 2) Include plans, elevations, sections, hardware mounting heights, and attachment details.
 - 3) Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4) Indicate locations of activation and safety devices.
 - 5) Include diagrams for power, signal, and control wiring.
 - c. Samples:
 - 1) Color charts.
 - 2) For each exposed product and for each color and texture specified, manufacturer's standard size.
 - d. Certificates:
 - 1) Qualification Data: For Installer.



- a) An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.
 - b) Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- 2) Product Certificates: For each type of automatic door operator. For each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.
- 3) Field quality-control reports.
- e. Qualification Statements:
 - 1) Certified by AAADM.

B. Closeout Submittals:

- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.
 - b. Warranty Documentation:
 - 1) Automatic Door Operators.

1.05 PREINSTALLATION MEETINGS

- A. Coordinate a Preinstallation Conference with the Program/Project Manager, Architect, Engineers, Security Consultant, Hardware Consultant, and all vested Groups.
 - 1. Conduct conference at Project site.

1.06 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:



1. Installer's Qualifications:
 - a. Engage an experienced installer who has specialized in installing automatic door operators similar to those required for this Contract, and who is acceptable to manufacturer, to assume responsibility for and to perform the Work of this Section.
 - b. Submit the automatic door operator installer's qualifications to the Program/Project Manager for approval.

C. Certifications:

1. Installer Certificates:
 - a. Submit Installer Certificates, signed by the aluminum entrance and storefront manufacturer, certifying that the installer is acceptable to the manufacturer for installing their products.
2. Product Certificates:
 - a. Provide product certificates for each type of automatic door operator.
 - b. Provide product certificates for each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.

1.07 WARRANTY

A. Special Warranty:

1. Warrant repair or replacement of the components of the automatic door operators that fail in materials or workmanship within specified warranty period.
 - a. Failures include, but are not limited to, the following:
 - 1) Faulty or sporadic operation of automatic door operator, including controls.
 - 2) Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
2. Warranty Period:
 - a. Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. LCN Closers; an Allegion company, www.allegion.com
 - b. SARGENT Manufacturing Company; an ASSA ABLOY Group company, www.assaabloy.com



- c. Stanley Access Technologies, LLC; Div. of Stanley Security Solutions, www.stanleysecuritysolutions.com
 - d. Approved equal.
 - 2. Substitution Limitations:
 - a. The Contract Drawings indicate the size, profiles, and dimensional requirements of the entrance and storefront systems, and are based on the specific systems indicated.
 - 1) Except with the Program/Project Manager's approval, do not provide products modifying the intended aesthetic effect indicated in the Contract Documents as judged solely by the Program/Project Manager, and then only to the extent needed to comply with performance requirements.
 - 2) Where modifications to the intended aesthetic effect are proposed, submit comprehensive explanatory data to Program/Project Manager for review and approval.
 - b. Subject to compliance with the requirements indicated in the Contract Documents, other manufacturers' systems with equal performance characteristics may be considered.
 - 3. Product Options:
 - a. Source Limitations:
 - 1) Obtain each type of entrance and storefront system through one source and from a single manufacturer.
- B. Performance:
- 1. Opening Force
 - a. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
 - b. Accessible Interior Doors: Not more than **5 lbf (22 N)** to push or pull door to fully open position.
 - 2. Entrapment-Prevention Force: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.
- C. Design Criteria:
- 1. General
 - a. Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and according to UL 325. Coordinate



operator mechanisms with door operation, hinges, and activation and safety devices.

- 1) Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- 2) Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind loads defined in the International Building Code.
- b. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.
- c. Hinges: See Section 08705 Finish Hardware for hinge type for each door that door operator shall accommodate.
- d. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch-(3.2-mm-) thick, extruded or formed aluminum; continuous over full width of operator-controlled door opening with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
- e. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.
- f. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.
- g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Configuration: Operator to control single swinging door.
 - a. Traffic Pattern: One way.
 - b. Operator Mounting: Surface.
3. Configuration: Operator to control pair of swinging doors.
 - a. Traffic Patter: One way.
 - b. Operator Mounting: Surface.
4. Operation:



- a. Low-energy door operators: Power opening and power-assisted spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
 - b. Power-assist door operators: Power-assisted opening that reduces the force to open door and power-assisted spring closing. Pushing or pulling on door activates operator. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
5. Operating System:
 - a. Electromechanical.
6. Features:
 - a. Adjustable opening and closing speeds
 - b. Adjustable opening and closing forces.
 - c. Adjustable independent electronic adjustment.
 - d. Adjustable backcheck valve.
 - e. Adjustable time delay.
 - f. Selectively activated by external initiating device.
7. Activation device:
 - a. Push-plate switch on each side of door to activate door operator.
8. Exposed Finish: Stainless Steel.
 - a. Color: As selected by Architect from full range of industry colors and color densities.
 - b. Metal Cladding: No. 4, directional-satin-finish stainless steel.
9. Product Data:
 - a. Submit Product Data for the automatic door operators, and hardware proposed for the Work of this Section to the Program/Project Manager for approval.
10. Shop Drawings:
 - a. For the automatic door operators provided, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Show fabrication and installation details, including plans, elevations, sections, details of the components, and attachments to other work.
 - 2) Include with the hardware schedule; and indicate operating hardware types, quantities, and locations.

D. Materials:

1. Stainless-Steel Sheet:



- a. Provide ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness, in manufacturer's standard thickness
 2. Polycarbonate Sheet:
 - a. Provide ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.
 3. Fasteners and Accessories:
 - a. Provide corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
- E. Accessories:
 1. Signage: As required by cited BHMA standard for type of door and its operation.
 - a. Application Process: Operator manufacturer's standard process.
 - b. Provide sign materials with instructions for field application when operators are installed.
- F. Controls
 1. General:
 - a. Provide controls, including activation and safety devices, according to BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
 2. Push-Plate Switch:
 - a. Momentary-contact door control switch with flat push-plate actuator with engraved message.
 - 1) Square Configuration:
 - a) Square push plate with 4-by-4-inch (100-by-100-mm) junction box
 - b) Mounting: Surface mounted on wall or post.
 - 2) Mullion Configuration:
 - a) Rectangular push plate with 2-by-4-inch (50-by-100-mm) junction box.
 - b) Mounting: As indicated on Drawings, Recess mounted in door jamb or mullion.
 - 3) Push-Plate Material: Stainless steel
 - 4) International symbol of accessibility and "Press to Open".
- G. Fabrication:
 1. Shop Fabrication:
 - a. Factory fabricate automatic door operators to comply with indicated standards.



2. Fabricate exterior components to drain condensation and water passing joints within operator enclosure to the exterior.
3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
4. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.
5. Shop Finishing Requirements:
 - a. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.
 - b. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
 - c. Appearance of Finished Work:
 - 1) Noticeable variations in same piece are not acceptable.
 - 2) Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
 2. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
 3. Verify that full-height finger guards are installed at each door with pivot hinges where door has a clearance at hinge side greater than **1/4 inch (6 mm)** and less than **3/4 inch (19 mm)** with door in any position.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.



3.02 INSTALLATION

- A. Install automatic door operators according to manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
 - 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 - 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
- B. Controls:
 - 1. Install activation and safety devices according to manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
- C. Access-Control System:
 - 1. Connect operators to access-control system as specified in Section 281300 "Access Control".
- D. Signage:
 - 1. Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Certified Inspector:
 - a. Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
 - 2. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - a. Test and inspect each automatic door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
 - 3. Prepare test and inspection reports.

B. Non-Conforming Work



1. Automatic door operators will be considered defective if they do not pass tests and inspections
2. Repair, or remove and replace, Work that does not meet the specified requirements, or that is damaged by testing.
 - a. Replace nonconforming work to conform to the specified requirements.

3.04 ADJUSTING

- A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 1. Adjust operators on exterior doors for weathertight closure.
- B. After completing installation of automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust automatic door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 CLEANING

- A. Remove excess sealant and grease, and dirt, from surfaces.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition



RFI
0390

Curtain Wall
Specification

SECTION 08800

GLAZING

PART 1 GENERAL

1.01 SUMMARY

Click hyperlink to see
the response
regarding a curtain
wall specification.

A. Section Includes:

1. Requirements for glazing at interior and exterior doors and windows, storefronts and entrances, borrowed lites, structural glass curtain walls, structural sealant glazed assemblies, and for glazing applications in other Sections where glazing requirements are specified by reference to this Section.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01454 - Mock-Up Requirements.
4. Section 01780 - Closeout Submittals.
5. Section 08411 - Aluminum-Framed Entrances and Storefronts.
6. Section 08520 - Aluminum Windows.
7. Section 08970 - Structural Glass Curtain Walls.
8. Section 08975 - Structural Sealant Glazed Assemblies.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. EPDM: Ethylene propylene diene terpolymer M-class rubber.
2. f. o. b.: Freight on board.
3. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
4. PVB: Polyvinyl butyral.
5. PVC: Polyvinyl-chloride.



6. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
7. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Definitions:

1. Standard glazing terms defined in the GANA Laminated Glazing Reference Manual, the GANA Glazing Manual, and IGMA TM-3000 apply to the Work of this Section.
2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
3. Damaged Glass: Glass having edge damage or other imperfections that, when installed, could weaken the glass and impair its performance and appearance.
4. Deterioration of Coated Glass: Defects developed from normal use attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions.
 - a. Defects include peeling, cracking, and other indications of deterioration in the metallic coating.
5. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions.
 - a. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of the glass.
6. Deterioration of Laminated Glass: Defects developed from normal use attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions.
 - a. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by the referenced laminated-glass standard.
7. Fire-Rated Door Assemblies: Assemblies complying with the requirements specified in NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to the Authorities Having Jurisdiction, for fire ratings indicated, based on testing in accordance with the methods specified in NFPA 252.



8. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
9. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
10. Low-E: Low-emissivity, a term used for a surface that radiates or emits, low levels of radiant energy.
11. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in the glazing publications referenced herein.
12. Safety Glass: Category II materials complying with testing requirements specified in 16 CFR 1201 and ANSI Z97.1.

C. Reference Standards:

1. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 800 – Voluntary Specifications and Test Methods for Sealants.
2. American National Standards Institute (ANSI):
 - a. ANSI Z97.1 – Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.
3. ASTM International (ASTM):
 - a. ASTM C 509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
 - b. ASTM C 542 - Standard Specification for Lock-Strip Gaskets.
 - c. ASTM C 716 - Standard Specification for Installing Lock-Strip Gaskets and Infill Glazing Materials.
 - d. ASTM C 864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
 - e. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.
 - f. ASTM C 1036 - Standard Specification for Flat Glass.
 - g. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
 - h. ASTM C 1115 – Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
 - i. ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass.
 - j. ASTM C 1281 – Standard Specification for Preformed Tape Sealants for Glazing Applications.
 - k. ASTM C 1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
 - l. ASTM C 1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
 - m. ASTM E 308 – Standard Practice for Computing the Colors of Objects by Using the CIE System.



- n. ASTM E 774 - Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units [*withdrawn 2006*].
 - o. ASTM E 903 – Standard Test Method for Solar Absorbance, Reflectance, and Transmittance of Materials Using Integrating Spheres [*withdrawn 2005*].
 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 5. Glass Association of North America (GANA):
 - a. GANA Engineering Standards Manual.
 - b. GANA Glazing Manual.
 - c. GANA Laminated Glazing Reference Manual.
 6. Insulating Glass Certification Council (IGCC), <http://www.igcc.org>:
 7. Insulating Glass Manufacturers Alliance (IGMA):
 - a. IGMA TM-3000 – North American Glazing Guidelines for Sealed Insulation Glass for Commercial and Residential Use.
 - b. IGMA TM-4000 – Insulating Glass Manufacturing Quality Procedures.
 8. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 9. Lawrence Berkeley National Laboratory (LBNL).
 - a. Environmental Energy Technologies Division:
 - 1) Building Technologies Department:
 - a) Windows & Daylighting Research Group:
 - (1) LBNL WINDOW 5.2 - A PC Program for Analyzing Window Thermal Performance,
<http://windows.lbl.gov/software/window/window.html>.
10. National Fire Protection Association (NFPA):
 - a. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
 - b. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
 - c. NFPA 257 - Standard for Fire Test for Window Glass Block Assemblies.
11. National Fenestration Rating Council Incorporated (NFRC):
 - a. NFRC 100 - Procedure for Determining Fenestration Product U-Factors.
 - b. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - c. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.
 - d. NFRC 700 - Product Certification Program.
 - e. NFRC 701 - Laboratory Accreditation Program Document.
12. National Glass Association (NGA):



- a. NGA Certification Program, Glass Installer,
<http://www.glass.org/certified-exam.html>.
- 13. Safety Glazing Certification Council, Inc. (SGCC):
 - a. SGCC Certification Process, <http://www.sgcc.org>.
- 14. United States Government:
 - a. Consumer Product Safety Commission (CPSC):
 - 1) 16 CFR 1201 – Safety Standard for Architectural Glazing Materials.
- 15. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Annealed float glass.
 - 2) Ultra-clear (low-iron) float glass.
 - 3) Heat-treated float glass.
 - 4) Sputter-coated float glass.
 - 5) Coated spandrel float glass.
 - 6) Laminated glass.
 - 7) Insulating-glass units.
 - 8) Fire-rated glazing.
 - 9) Glazing tapes.
 - 10) Glazing gaskets.
 - 11) Cleaners, primers, and sealers.
 - 12) Setting blocks.
 - 13) Spacers.
 - 14) Edge blocks.
 - 15) Cylindrical glazing sealant backing.
 - 16) Perimeter insulation for fire-resistive glazing.
 - 17) Frosted glass film.
 - 18) Opaque glazing film.
 - b. Shop Drawings:
 - 1) Glazing systems.
 - c. Samples:
 - 1) Sample of each color of tinted float glass.
 - 2) Samples of coated vision glass.
 - 3) Samples of coated spandrel glass.



- 4) Samples of fire-resistive glazing products.
 - 5) Sample of each type of laminated glass including the interlayer.
 - 6) Samples of insulating glass units for each designation indicated.
 - d. Delegated Design Submittals:
 - 1) Engineering analysis to determine the thicknesses of glazing for each application.
 - e. Certificates:
 - 1) Glazing manufacturer's Certificates of Compliance.
 - f. Qualification Statements:
 - 1) Glass installer's qualifications.
 - 2) Glass Testing and Inspection Agency's qualifications.
 - 3) Professional Engineer's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Glass, sealant, gasket, and other glazing material manufacturers written installation instructions.
 - b. Site Quality Control Submittals:
 - 1) Coated float glass test reports.
 - 2) Insulating glass test reports.
 - 3) Glazing gasket test reports.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Glazing Installer's Warranty.
 - 2) Coated-Glass Products Manufacturer's Warranty.
 - 3) Laminated Glass Products Manufacturer's Warranty.
 - 4) Insulating Glass Products Manufacturer's Warranty.

1.04 QUALITY ASSURANCE

A. Qualifications:



1. Glass Installer Qualifications:
 - a. Employ an experienced Certified Glass Installer certified under the NGA Certification Program, and who has completed glazing similar in material, design, and extent to that indicated for this Contract, and whose work has resulted in construction with a record of successful in-service performance.
 - b. Submit the glass installer's qualifications to the Program/Project Manager for approval.
2. Glass Testing and Inspection Agency's Qualifications:
 - a. Employ an independent testing agency accredited according to the requirements of the National Fenestration Rating Council Incorporated (NFRC) Laboratory Accreditation Program as specified in NFRC 701.
 - b. Insulating-Glass Certification Testing and Inspection Agency Qualifications:
 - 1) Employ an independent testing agency accredited according to the requirements of the Insulating Glass Certification Council specified in IGMA TM-4000.
 - c. Submit the glass Testing and Inspection Agency's qualifications to the Program/Project Manager for approval.
3. Professional Engineer's Qualifications:
 - a. Employ an independent Professional Engineer, registered in the State of Arizona, who is qualified to perform the engineering analysis work required under this Section.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.

B. Certifications:

1. Glazing Manufacturer's Certificates of Compliance:
 - a. Submit the glazing manufacturer's Certificates of Compliance, signed by the safety glass and glazing products manufacturer, and certifying that the safety glass and glazing products being provided comply with the specified requirements, to the Program/Project Manager for approval.
 - 1) For solar-control low-e-coated glass, submit documentation demonstrating that the manufacturer of the coated glass is certified by the coating manufacturer.
2. Safety Glazing Certification:
 - a. Subject to compliance with requirements specified, provide certified safety glass permanently marked with the certification label of the Safety Glazing Certification Council, Inc. (SGCC) or another certification agency acceptable to the Authorities Having Jurisdiction.
3. Insulating-Glass Certification:



- a. Provide insulating-glass that is certified by the Insulating Glass Certification Council (IGCC) to comply with the requirements specified in IGMA TM-3000, and permanently marked with the either on spacers or on at least one component lite of the units with the appropriate certification IGCC/IGMA mark of the Insulating Glass Certification Council (IGCC).
 - 1) The glass must be produced in an IGCC/IGMA Certified Fabrication Facilities plant, certified in accordance with the requirements specified in IGMA TM-4000.
- C. Preconstruction Testing:
 1. Where adhesion of sealants to substrates may be problematic, perform preconstruction sealant-substrate testing to determined compatibility and the need of primers to be applied to the joint surfaces.
- D. Site Samples:
 1. Obtain Samples of the following products, for glass in the form of 12-inch square Samples and for sealants in the form of 12-inch long Samples installed between 2 strips of material representative of the color of the adjoining framing system:
 - a. Each color of tinted float glass.
 - b. Coated vision glass.
 - c. Coated spandrel glass.
 - d. Fire-resistive glazing products.
 - e. Each type of laminated glass including the interlayer.
 - f. Insulating glass units for each designation indicated.
 2. Submit the Samples to the Program/Project Manager for approval.
- E. Mock-Ups:
 1. Build mockups in accordance with the requirements specified in Section 01454, Mock-Up Requirements.
 - a. Build the mockups in the location and of the size indicated or, if not indicated, as directed by Program/Project Manager.
 - b. Build glass mockups as specified in Section 08411, Aluminum-Framed Entrances and Storefronts, Section 08520, Aluminum Windows, Section 08970, Structural Glass Curtain Walls, and Section 08975, Structural Sealant Glazed Assemblies using the glazing methods to be used for production Work to install the following glass, matching the glazing systems required for this Contract, in the mockups:
 - 1) Heat-strengthened coated glass.
 - 2) Fully tempered glass.
 - 3) Spandrel glass.



- 4) Laminated glass.
2. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing the glass to avoid hermetic seal ruptures.
- B. Storage and Handling Requirements:
 1. Protect glazing materials in accordance with the manufacturer's written instructions and as needed to prevent damage to the glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
 - a. Protect glass edges from damage during handling and installation.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.06 SITE CONDITIONS

- A. Ambient Conditions:
 1. Environmental Limitations:
 - a. Do not proceed with glazing when the ambient and substrate temperature conditions are outside the limits permitted by the glazing material manufacturers, or when the glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.07 WARRANTY

- A. Special Warranties:
 1. The warranties specified in this Paragraph do not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents; and are in addition to, and run concurrent with, other warranties made under other requirements of the Contract Documents.
 2. Glazing Installer's Special Warranty:
 - a. Furnish a written Glazing Installer's Warranty on the installer's standard form in which the glazing installer agrees, at no increase in



the Contract Price, to repair or replace glazing, including float glass, wire glass, and insulated glass, that does not comply with the performance and other requirements specified in this Section within a 5-year warranty period from the date of Substantial Completion.

- 1) Submit the Glazing Installer's Warranty to the Program/Project Manager.
3. Coated-Glass Products Manufacturer's Special Warranty:
 - a. Furnish a written Coated-Glass Products Manufacturer's Warranty made out to the Owner and signed by the coated-glass manufacturer in which the coated-glass products manufacturer agrees, at no increase in the Contract Price, to furnish coated-glass products to replace those that do not comply with performance and other requirements specified in this Section and/or that deteriorate as defined in Subparagraph 1.02.B.4 within a 10-year warranty period from the date of Substantial Completion, f.o.b. at the nearest shipping point to the Site.
 - 1) Submit the Coated-Glass Products Manufacturer's Warranty to the Program/Project Manager.
4. Laminated Glass Products Manufacturer's Special Warranty:
 - a. Furnish a written Laminated Glass Products Manufacturer's Warranty made out to the Owner and signed by the laminated glass manufacturer in which the laminated glass products manufacturer agrees, at no increase in the Contract Price, to furnish laminated glass products to replace those that do not comply with performance and other requirements specified in this Section and/or that deteriorate as defined in Subparagraph 1.02.B.6 within a 5-year warranty period from the date of Substantial Completion, f.o.b. at the nearest shipping point to the Site.
 - 1) Submit the Laminated Glass Products Manufacturer's Warranty to the Program/Project Manager.
5. Insulating Glass Products Manufacturer's Special Warranty:
 - a. Furnish a written Insulating Glass Products Manufacturer's Warranty made out to the Owner and signed by the insulating glass manufacturer in which the insulating glass products manufacturer agrees, at no increase in the Contract Price, to furnish insulating glass products to replace those that do not comply with performance and other requirements specified in this Section and/or that deteriorate as defined in Subparagraph 1.02.B.5 within a 10-year warranty period from the date of Substantial Completion, f.o.b. at the nearest shipping point to the Site.



- 1) Submit the Coated-Glass Products Manufacturer's Warranty to the Program/Project Manager.

PART 2 PRODUCTS

2.01 GLAZING SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. If manufacturers are listed for the products specified in this Section, subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings:
 - 1) If solar-control low-e coatings are to be provided by a primary glass manufacturer that has established a certified fabricator program, obtain the sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by the coated-glass manufacturer.
 - c. Source Limitations for Glazing Accessories:
 - 1) Obtain glazing accessories for each product and installation method indicated for the Work of this Section from one source and from a single manufacturer.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
2. Sustainable Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:



- a) Architectural Sealants: Not more than 250 grams per Liter less water.

C. Performance:

1. Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
2. Thermal Movements:
 - a. Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components:
 - 1) Ambient Temperature Change (Range): 120 degrees Fahrenheit.
 - 2) Material Surfaces Temperature Change (Range): 180 degrees Fahrenheit.
 - a) Base the engineering calculations on the surface temperatures of the materials due to both the solar heat gain and the nighttime-sky heat loss.
3. Thermal and Optical Performance Properties:
 - a. Provide glass having the performance properties specified based on the manufacturer's published test data determined in accordance with the procedures indicated below:
 - 1) For laminated-glass lites, base properties on products of the construction indicated.
 - 2) For insulating-glass units, base properties on units having the thickness indicated for the overall unit and for each lite.
 - 3) Center-of-Glass Values:
 - a) Base center-of-glass values on using the LBNL WINDOW 5.2 computer program methodologies for the following:
 - (1) U-Factors:
 - (a) Base the center-of-glass U-factors on the NFRC 100 methodology expressed as Btu per square foot-hour-degree Fahrenheit.
 - (2) Solar Heat Gain Coefficient:
 - (a) Base the center-of-glass solar heat gain coefficient on the NFRC 200 methodology.
 - (3) Solar Optical Properties:
 - (a) Base the center-of-glass solar optical properties on the NFRC 300 methodology.



D. Design Criteria:

1. Provide glazing products of the material, size, and shape complying with the referenced glazing standards, the requirements of the manufacturers of glass and other glazing materials for the application indicated, and having a proven record of compatibility with the surfaces that will be contacted during installation.
2. Thicknesses:
 - a. Delegated Design Responsibility:
 - 1) The manufacturer is responsible for determining the required thicknesses of glazing for each application.
 - a) Provide the thicknesses required by engineering analysis, but not less than the minimum thicknesses indicated in the Contract Documents.
 - (1) Have the engineering analysis performed by a Professional Engineer.
 - (2) Submit the engineering analysis to determine the thicknesses of glazing for each application, certified by the Professional Engineer, to the Program/Project manager for information.
 - b) Prepare data for the system, including Shop Drawings, based on a testing and engineering analysis of the manufacturer's standard products applied to applications similar to those indicated for this Contract.
 - (1) Submit the Shop Drawings of the glazing systems to the Program/Project manager for approval.
 - 2) Provide glazing designed in accordance with the published recommendations of the glass product manufacturers and the following references, unless more stringent requirements are indicated in the Contract Documents.
 - a) GANA Laminated Glazing Reference Manual.
 - b) GANA Glazing Manual.
 - c) IGMA TM-3000.
 - b. The glass thickness designations indicated in the Contract Documents are minimums, and are only for detailing.
 - 1) Confirm the glass thicknesses by analyzing the Contract loads and in-service conditions.
 - 2) Provide glass lites of the thickness designations indicated for various size openings, but not less than the thicknesses and strengths (annealed or heat treated) required to meet or exceed the indicated criteria.



- c. Select minimum glass thicknesses complying with the requirements specified in ASTM E 1300, according to the following requirements:
 - 1) Design Wind Loads: As specified in the Contract Documents.
 - 2) Probability of Breakage for Vertical Glazing:
 - a) For lites set vertically or not more than 15 degrees off vertical and under wind action, use 8 lites per 1000.
 - b) Load Duration: 3 seconds.
 - 3) Maximum Lateral Deflection:
 - a) For the following types of glass supported on all 4 edges, provide the thickness required to limit the center deflection at the design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
 - (1) Monolithic-glass lites heat treated to resist wind loads.
 - (2) Insulating glass.
 - (3) Laminated-glass lites.
 - 4) Minimum Glass Thickness for Exterior and Interior Lites:
 - a) For exterior and interior lites, provide glass not less than 6.0mm thick.
- 3. Glazing for Fire-Rated Door Assemblies:
 - a. For fire-rated door assemblies, provide glazing that complies with the requirements specified in NFPA 80, and that is listed and labeled for the fire-protection ratings indicated in the Contract Documents by a Testing and Inspecting Agency acceptable to the Authorities Having Jurisdiction based on testing performed in accordance with the methods specified in NFPA 252.
- 4. Glazing for Fire-Rated Window Assemblies
 - a. For fire-rated window assemblies, provide glazing that complies with the requirements specified in NFPA 80, and that is listed and labeled for the fire-protection ratings indicated in the Contract Documents by a Testing and Inspecting Agency acceptable to the Authorities Having Jurisdiction based on testing performed in accordance with the methods specified in NFPA 257.
- 5. Safety Glazing Products:
 - a. Provide safety glazing products complying with the testing requirements specified in 16 CFR 1201.
 - 1) For glazing lites having an exposed surface area on one side of more than 9 square feet, including Kind FT glass and laminated glass, provide glazing products complying with the requirements for Category II materials specified in 16 CFR 1201.
 - 2) For glazing lites having an exposed surface area on one side of 9 square feet or less, provide glazing products complying with the



- requirements for Category I or II materials specified in 16 CFR 1201, except for hazardous locations where Category II materials are required by 16 CFR 1201 and the regulations of the Authorities Having Jurisdiction..
6. Elastomeric Glazing Sealants:
 - a. Provide elastomeric glazing sealant products of the type indicated, and complying with the following requirements:
 - 1) Compatibility:
 - a) Select glazing sealants that are compatible with one another and the other materials they will be in contact with under the conditions of service and application as demonstrated by the sealant manufacturer based on testing and field experience, including glass products, seals of insulating-glass units, and glazing channel substrates.
 - 2) Suitability:
 - a) Comply with the sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for the applications indicated in the Contract Documents and for the conditions existing at time of installation.
 - 3) Colors of Exposed Glazing Sealants:
 - a) Provide glazing sealants for exposed applications having the colors selected by the Program/Project Manager from the manufacturer's full range of colors.
 - b. Elastomeric Glazing Sealant Standard:
 - 1) For each liquid-applied, chemically curing sealant, provide elastomeric glazing sealants complying with the requirements for type, grade, class, and uses specified in ASTM C 920 and with other requirements indicated in the Contract Documents.
 - c. Glazing Sealant for Fire-Resistive Glazing Products:
 - 1) Provide glazing sealant for fire-resistive glazing products identical to the product used in the test assembly to obtain the fire-protection rating.
 7. Product Data:
 - a. Obtain Product Data for each glass product and glazing material indicated in the Contract Documents.
 - b. Submit the Product Data to the Program/Project Manager for approval.

E. Materials

1. Annealed Float Glass:



- a. Provide annealed float glass complying with the requirements for Type I (transparent flat glass), Quality-Q3, Class 1 (clear) glass specified in ASTM C 1036.
 - 1) Where heat strengthened glass is required to resist thermal stresses induced by differential shading of individual glass lites, and to comply with system performance requirements indicated in the Contract Documents, provide Kind HS (heat-strengthened) float glass or Kind FT (fully tempered) float glass.
- b. Thickness:
 - 1) Provide annealed float glass that is at least 6.0mm thick.
2. Ultra-Clear (Low-Iron) Float Glass:
 - a. Provide ultra-clear (low-iron) float glass complying with the requirements for Type I (transparent flat glass), Quality-Q3, Class 1 (clear) glass specified in ASTM C 1036, and having visible light transmission of at least 91 percent and a solar heat gain coefficient of at least 0.87.
 - b. Thickness:
 - 1) Provide ultra-clear (low-iron) float glass that is at least 6.0mm thick.
 - c. Manufacturers:
 - 1) AFG Industries Inc., Krystal Klear, <http://www.afgglass.com>.
 - 2) Pilkington Building Products North America, Optiwhite, <http://www.pilkington.com/the+americas/usa/english/pilkington+in+the+usa/default.htm>.
 - 3) PPG Industries, Inc., Starphire, <http://corporateportal.ppg.com/ppg>.
 - 4) Approved equal.
3. Heat-Treated Float Glass:
 - a. Provide heat-treated float glass complying with the requirements for Type I (transparent flat glass), Quality-Q3, Class 1 (clear) annealed glass specified in ASTM C 1048, and having the Condition indicated in the Contract Documents.
 - 1) For uncoated glass, provide glass complying with the requirements for Condition A (uncoated surfaces) specified in ASTM C 1048 unless otherwise indicated.
 - 2) For coated vision glass, provide glass complying with the requirements for Condition C (other coated glass) specified in ASTM C 1048 unless otherwise indicated.
 - b. Fabrication Process
 - 1) At the manufacturer's option, provide heat-treated float glass fabricated using either the vertical (tong-held) or horizontal (roller-



- hearth) process with the roll-wave distortion parallel to the bottom edge of the glass as installed, except where tongless or free of tong marks is indicated.
- c. Where heat strengthened glass is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements, provide Kind FT (fully tempered) float glass.
 - 1) Color:
 - a) Unless otherwise indicated, provide grey glass having low-E values.
 - d. Where safety glass is required to comply with system performance requirements, provide Kind HS (heat-strengthened) float glass.
 - e. Thickness:
 - 1) Provide heat-treated float glass that is at least 6.0mm thick.
4. Sputter-Coated Float Glass:
- a. Provide sputter-coated float glass complying with the requirements for Class 1 (clear) annealed float glass specified in ASTM C 1036, and having metallic-oxide or metallic -nitride coating deposited by vacuum deposition process complying with the requirements specified in ASTM C 1376 after manufacture and heat treatment (if any).
 - 1) Where heat strengthening is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with system performance requirements, provide Kind HS (heat-strengthened) sputter-coated float glass.
 - 2) Where indicated in the Contract Documents, provide Kind FT (fully tempered) sputter-coated float glass.
 - b. Thickness:
 - 1) Provide sputter-coated float glass that is at least 6.0mm thick.
 - c. Reflective Coating:
 - 1) Provide a reflective sputtered coating on the sputter-coated float glass.
 - d. Location:
 - 1) Provide sputter-coated float glass in insulating glazing units.
 - e. Manufacturers:
 - 1) Viracon, VE1-2M or VE1-48 as scheduled except as indicated otherwise, <http://www.viracon.com>.
 - 2) Approved equal.
5. Coated Spandrel Float Glass:
- a. Provide coated spandrel float glass complying with other requirements specified, and with the following additional requirements:
 - 1) Fallout Resistance:



- a) Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.
- 2) Factory-apply the manufacturer's standard opacifier material to the coated second surface of the lites over the reflective coating so the resulting products comply with the requirements specified in Specification No. 89-1-6 "Opacifier Color" in the GANA Engineering Standards Manual.
 - a) Match the color of the Program/Project Manager's approved Sample.
- 6. Laminated Glass:
 - a. Provide laminated glass complying with the requirements for Kind LA having 2 lites of annealed float glass specified in ASTM C 1172, and complying with the following additional requirements:
 - 1) Outer Lite:
 - a) Provide an outer lite for laminated glass consisting of Class 1 (clear) float glass.
 - b) Thickness:
 - (1) Provide an outer lite for laminated glass that is 6.0mm thick.
 - 2) Plastic Interlayer:
 - a) Provide a polyvinyl butyral interlayer having a history of not bubbling, discoloring, or losing its physical and mechanical properties after laminating the glass lites and installation.
 - (1) For polyvinyl butyral (PVB) interlayers, laminate the lites in an autoclave using heat plus pressure.
 - b) Thickness:
 - (1) Provide an interlayer for laminated glass that is 0.030 inch thick, but not less than the thickness required to comply with the requirements specified for Type II safety glass material specified in 16 CFR 1201.
 - c) Interlayer Color:
 - (1) Provide an interlayer for laminated glass that is clear.
 - 3) Inner Lite:
 - a) Provide an inner lite for laminated glass consisting of Class 1 (clear) float glass.
 - b) Thickness:
 - (1) Provide an inner lite for laminated glass that is 6.0mm thick.
 - b. Laminating Process:
 - 1) Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.



7. Insulating-Glass Units:
 - a. Provide factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with the requirements for Class CBA units specified in ASTM E 774.
 - 1) Where heat strengthening is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements, provide Kind HS (heat-strengthened) annealed insulating-glass.
 - 2) Where indicated in the Contract Documents, provide Kind FT (fully tempered) safety (tempered) glass.
 - b. Overall Unit Thickness and Thickness of Each Lite:
 - 1) Dimensions indicated for insulating-glass units in Schedule 08800-1 Exterior Glazing Units attached to the end of this Section are nominal, and the overall thicknesses of units are measured perpendicularly from the outer surfaces of the glass lites at the unit's edge.
 - c. Sealing System:
 - 1) Provide dual seal insulating-glass units that use primary and secondary sealants incorporating the manufacturer's standard sealants.
 - d. Spacer Specifications:
 - 1) Provide insulating-glass units that incorporate the manufacturer's standard spacer material and construction.
 - e. Color:
 - 1) Provide insulating-glass units fabricated using grey glass with low-E values.
8. Fire-Rated Glazing:
 - a. Laminated Glass Having Intumescent Interlayers:
 - 1) Provide proprietary laminated glass having intumescent interlayers that complies with the requirements specified for Category II safety glazing products in 16 CFR 1201, and for glazing having multiple lites of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Kind FT (fully tempered) float glass specified in ASTM C 1036 and ASTM C 1048.
 - 2) Fire-Protection Rating:
 - a) Provide fire-rated glazing having the fire-protection rating indicated in the Contract Documents for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to the Authorities Having Jurisdiction.



- 3) Logo:
 - a) Label each piece of fire-rated glazing with a permanent logo that includes the name of the product, the manufacturer, the testing laboratory (UL), the fire rating period, the safety glazing standards, and the date of manufacture.
 - b. Manufacturers:
 - 1) Pilkington Building Products North America, distributed by Technical Glass Products, PyroStop,
<http://www.pilkington.com/the+americas/usa/english/pilkington+in+the+usa/default.htm>.
 - 2) Approved equal.
9. Glazing Tapes:
 - a. Back-Bedding Mastic Glazing Tape:
 - 1) Provide preformed, butyl-based elastomeric back-bedding mastic glazing tape having a solids content of 100 percent, packaged on rolls with a release paper backing, and complying with the requirements specified in ASTM C 1281 and in AAMA 800 for the following products:
 - a) Where indicated in the Contract Documents for less-severe back-bedding and drop-in glazing applications, provide back-bedding mastic glazing tapes complying with the requirements specified in AAMA 804.3 which is included in AAMA 800.
 - b) Where indicated in the Contract Documents for high-performance glazing applications involving continuous pressure from gaskets or pressure-generating stop designs, provide back-bedding mastic glazing tapes complying with the requirements specified in AAMA 806.3 which is included in AAMA 800.
 - c) Where indicated in the Contract Documents for glazing applications not involving continuous pressure from gaskets and stop designs, provide back-bedding mastic glazing tapes complying with the requirements specified in AAMA 807.3 which is included in AAMA 800.
 - 2) Provide back-bedding mastic glazing tape that is non-staining and non-migrating when in contact with nonporous surfaces.
 - 3) Provide back-bedding mastic glazing tape with or without spacer rod as recommended in writing by the tape and glass manufacturers for the application indicated in the Contract Documents.
 - b. Expanded Cellular Glazing Tape:



- 1) Provide closed-cell, polyvinyl-chloride (PVC) foam tape, factory-coated with adhesive on both surface, packaged on rolls with release liner protecting adhesive; and complying with the requirements specified in AAMA 800 for the following types:
 - a) Type 1, for glazing applications in which the tape acts as the primary sealant.
 - b) Type 2, for glazing applications in which the tape is used in combination with a full bead of liquid sealant.

10. Glazing Gaskets:

a. Lock-Strip Gaskets:

- 1) Provide black lock-strip gaskets complying with the requirements specified in ASTM C 542, and fabricated from neoprene extrusions of the size and shape indicated in the Contract Documents that have been placed into frames with molded corner units and zipper lock strips.

b. Dense Compression Gaskets:

- 1) Provide dense compression gaskets having the profile and hardness required to maintain a watertight seal, fabricated from the following molded or extruded gasket materials, and complying with the requirements specified in the standards referenced:
 - a) Neoprene:
 - (1) Provide gaskets fabricated from neoprene complying with the requirements specified in ASTM C 864.
 - b) Ethylene Propylene Diene Terpolymer M-Class Rubber (EPDM):
 - (1) Provide gaskets fabricated from ethylene propylene diene terpolymer M-class rubber (EPDM) complying with the requirements specified in ASTM C 864.
 - c) Silicone:
 - (1) Provide gaskets fabricated from silicone complying with the requirements specified in ASTM C 1115.
 - d) Thermoplastic polyolefin rubber:
 - (1) Provide gaskets fabricated from thermoplastic polyolefin rubber complying with the requirements specified in ASTM C 1115.

c. Soft Compression Gaskets:

- 1) Provide black soft compression gaskets having the profile and hardness required to maintain a watertight seal, fabricated from the following molded or extruded, closed-cell, integral-skinned gasket materials; and complying with the requirements for Type II gasket material specified in ASTM C 509:



- a) Neoprene.
 - b) Ethylene propylene diene terpolymer M-class rubber (EPDM).
 - c) Silicone.
 - d) Thermoplastic polyolefin rubber.
- F. Fabrication:
- 1. Fabricate glass and other glazing products of the sizes required to glaze the openings indicated in the Contract Documents, with edge and face clearances, edge and surface conditions, and bite complying with the written instructions of the product manufacturer and referenced glazing standard so they will comply with the system performance requirements.
 - 2. Grind smooth and polish exposed glass edges and corners.
 - 3. Clean-cut or flat-grind the vertical edges of butt-glazed monolithic lites to produce square edges with slight kerfs at the junctions with outdoor and indoor faces.

2.02 ACCESSORIES

- A. Cleaners, Primers, and Sealers:
- 1. Provide the types of cleaners, primers, and sealers recommended by the sealant or gasket manufacturer.
- B. Setting Blocks:
- 1. Provide setting blocks fabricated from elastomeric material having a Shore A durometer hardness of 85, plus or minus 5.
- C. Spacers:
- 1. Provide elastomeric spacer blocks or continuous extrusions having the Shore A durometer hardness required by the glass manufacturer to maintain the glass lites in place for the installation indicated in the Contract Documents.
- D. Edge Blocks:
- 1. Provide edge blocks fabricated from elastomeric material having the hardness needed to limit lateral movement of the glass (side walking).
- E. Cylindrical Glazing Sealant Backing:
- 1. Provide cylindrical glazing sealant backing complying with the requirements for Type O (open-cell material) backing material specified in ASTM C 1330, and having the size and density to control the glazing sealant depth and to otherwise produce optimum glazing sealant performance.



- F. Perimeter Insulation for Fire-Resistive Glazing:
1. Provide perimeter insulation for fire-resistive glazing that is identical to the product used in the test assembly to obtain the fire-resistance rating.
- G. Frosted Glazing Film:
1. To simulate an acid-etched appearance on the glass surface, provide 2mm-thick self-adhering frosted glazing film for application to the glass surface.
 2. Color:
 - a. Provide a color equivalent to "Dusted Crystal" as supplied by 3M.
 3. Manufacturers:
 - a. 3M™, Scotchcal™ ElectroCut Graphic Film 7725SE-314 "Dusted Crystal", <http://www.3m.com/product/information/Scotchcal-Film.html>.
 - b. Approved equal.
- H. Opaque Glazing Film:
1. To simulate an opaque appearance on the glass surface, provide 2mm-thick self-adhering opaque white glazing film for application to the glass surface complying with the following requirements:
 - a. Ultraviolet Radiation Rejected:
 - 1) Provide opaque glass film rejecting not less than 99 percent of the incident ultraviolet radiation when measured in accordance with the method specified in ASTM E 903.
 - b. Visible Light Transmission:
 - 1) Provide opaque glass film transmitting not more than 6 percent of the incident visible light when measured in accordance with the methods specified in ASTM E 308 and ASTM E 903.
 - c. Visible Light Rejected:
 - 1) Provide opaque glass film rejecting not less than 52 percent of the incident visible light when measured in accordance with the method specified in ASTM E 903.
 - d. Solar Heat Reduction:
 - 1) Provide opaque glass film reducing not less than 41 percent of the solar heat
 - e. Shading Coefficient at 90 Degrees (Normal Incidence):
 - 1) Provide opaque glass film having a shading coefficient at 90 degrees (normal incidence) not less than 0.29 when measured in accordance with the method specified in ASTM E 903.
 2. Manufacturers:
 - a. 3M™, Fasara™ Opaque White Decorative/Privacy Glazing Film, http://solutions.3m.com/en_US.
 - b. Approved equal.



- I. Ceramic Frit:
 1. Provide ceramic frit consisting of minute glass particles, pigment, and a medium mixed together to form an enamel.
 - a. Basis-of-Design Product: Viracon; Viraspan Design – Silk-screen Pattern: Dot/Hole Series, 5960: 50% Coverage ¼ inch Dots. Viraspan Ceramic Frit color: High-opacity white (V-175). www.viracon.com.
 - b. Product: Viracon; Viraspan Design – Silk screen Pattern: VE-48 screen #2125 #2: 80% coverage, Lines. Ceramic Frit Color: V1086 – Simulated Sandblast Viraspan #2.
 2. Using a silk screen process, apply the ceramic frit to the glass surface; then fire the enamel creating a permanent coating.
 3. Manufacturers:
 - a. Viracon, <http://www.viracon.com>.
 - b. Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the glazing installer present, examine framing glazing to verify compliance with the following requirements:
 - a. Manufacturing and installation are within required tolerances, including the tolerances for size, squareness, and offsets at corners.
 - b. A weep system is present and properly functioning.
 - c. The minimum required face or edge clearances are present.
 - d. The joints between the glass-framing members have been effectively sealed.
- B. Evaluation and Assessment:
 1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the glazing.
- B. Surface Preparation:
 1. Immediately before beginning glazing, clean the glazing channels and other framing members to receive the glass.
 - a. Remove coatings not firmly bonded to the substrates.



2. Where required for adhesion of sealants as determined by preconstruction sealant-substrate testing, apply primers to the joint surfaces.

3.03 INSTALLATION

A. Glazing

1. Comply with combined written instructions of the manufacturers of the glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in the referenced glazing publications.
 - a. Submit the glass, sealant, gasket, and other glazing material manufacturers written installation instructions to the Program/Project Manager for information.
2. Glazing channel dimensions, as indicated on the Contract Drawings, provide the necessary bite on the glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
 - a. Adjust the glazing channel dimensions as required by Contract conditions during installation.
3. Unless otherwise required by the glass manufacturer, install setting blocks in the sill rabbets, sized and located to comply with the referenced glazing publications.
 - a. Set the blocks in a thin course of compatible sealant suitable for the heel bead.
4. Do not exceed the edge pressures stipulated by the glass manufacturers for installing the glass lites.
5. Where the length plus the width of the glazing is larger than 50 inches, provide spacers for glass lites as follows:
 - a. Locate the spacers directly opposite each other on both inside and outside faces of glass.
 - 1) Install the spacers of the correct size and at the correct spacing to preserve the required face clearances, unless gaskets and glazing tapes are used that have a demonstrated ability to maintain the required face clearances and to comply with the system performance requirements.
 - b. Provide 1/8-inch minimum bite of the spacers on the glass, and use the thickness equal to the sealant width.
 - c. If using glazing tape, use a thickness slightly less than the final compressed thickness of the tape.
6. Where indicated on the Contract Drawings or needed to prevent glass lites from moving sideways in the glazing channel, provide edge blocking, as



recommended by glass manufacturer in writing and according to the requirements in the referenced glazing publications.

7. Set glass lites in each series so they have a uniform pattern, draw, bow, and similar characteristics.
8. Where wedge-shaped gaskets are driven into one side of the channel to pressurize sealant or the gasket on opposite side, provide adequate anchorage so the gasket cannot walk out when the installation is subjected to movement.
9. Square cut wedge-shaped gaskets at corners, and install gaskets in a manner recommended by the gasket manufacturer to prevent the corners from pulling away.
 - a. Seal corner joints and butt joints with the sealant recommended by the gasket manufacturer.

B. Tape Glazing

1. Position tapes on fixed stops so that when the stops are compressed by the glass their exposed edges are flush with or protrude slightly above the sightline of stops.
2. Install tapes continuously, but not necessarily in one continuous length.
 - a. Do not stretch tapes to make them fit the opening.
3. Cover vertical framing joints by applying tapes to the heads and sills first, and then to jambs.
4. Cover horizontal framing joints by applying tapes to the jambs, and then to the heads and sills.
5. Locate the joints in tapes at the corners of the opening, and having the adjoining lengths butted together, not lapped.
 - a. Seal joints in tapes using compatible sealant approved by the tape manufacturer.
6. Do not remove release paper from the tape until just before each glazing unit is installed.
7. Apply a heel bead of elastomeric sealant.
8. Center glass lites in the openings on setting blocks, and press firmly against the tape by inserting dense compression gaskets formed and installed to lock in place against the faces of the removable stops.
 - a. Start gasket applications at the corners, and work toward the centers of openings.
9. Apply a cap bead of elastomeric sealant over the exposed edge of the tape.

C. Gasket Glazing (Dry):



1. Fabricate compression gaskets of the lengths recommended by the gasket manufacturer to fit the openings exactly, and include a stretch allowance for installation.
2. Insert soft compression gaskets between the glass and frame or fixed stop so it is securely in place, and miter-cut and bond joints together at corners.
3. Center glass lites in the openings on setting blocks, and press firmly against the soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against the faces of the removable stops.
 - a. Start gasket applications at corners, and work toward centers of openings.
 - b. Compress the gaskets to produce a weathertight seal without developing bending stresses in the glass.
 - c. Seal gasket joints using the sealant recommended by the gasket manufacturer.
4. Install gaskets so they protrude past the face of the glazing stops.

D. Sealant Glazing (Wet):

1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between the glass lites and the glazing stops to maintain glass face clearances and to prevent sealant from extruding into the glass channel and blocking the weep systems until sealants cure.
 - a. Secure the spacers or spacers and backings in place and in position to control the depth of installed sealant relative to the edge clearance for optimum sealant performance.
2. Force sealants into the glazing channels to eliminate voids and to ensure complete wetting or bonding of the sealant to the glass and channel surfaces.
3. Tool exposed surfaces of the sealants to provide a substantial wash away from the glass.

E. Lock-Strip Gasket Glazing:

1. Install lock-strip gasket glazing in accordance with the requirements specified in ASTM C 716 and the gasket manufacturer's written instructions.
2. Provide a supplementary wet seal and weep system, unless otherwise indicated in the Contract Documents.

3.04 REPAIR/RESTORATION

- A. Remove glass that is broken, chipped, cracked, abraded, or damaged in any way, including damage resulting from natural causes, accidents, and



vandalism, during the construction period; and replace the damaged glass with new undamaged glass.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Have the Glass Testing and Inspection Agency perform tests on the following types of glass products to verify that they comply with the requirements specified herein, and have the Glass Testing and Inspection Agency submit certified test reports of the test results to the Program/Project Manager for information:
 - a. Coated float glass.
 - b. Insulating glass.
 - c. Glazing gaskets.

3.06 CLEANING

- A. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains.
 - 1. Remove the dirt, scum, alkaline deposits, and stains as recommended by the glass manufacturer.
- B. Not more than 4 days before the date scheduled for the inspections to establish the date of Substantial Completion in each area of the Contract, wash the glass on both exposed surfaces as recommended by the glass manufacturer.
 - 1. Remove nonpermanent labels, and clean the glass surfaces.
- C. Waste Management:
 - 1. Remove damaged glass from the Site, and legally dispose of it off the Site.
 - 2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. To protect exterior glass from damage immediately after installation, attach crossed streamers to the framing and held away from glass.
 - 1. Do not apply markers to the glass surface.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter.



1. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

3.08 ATTACHMENTS

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:

1. Schedule 08800-1 Exterior Glazing Units.
2. Schedule 08800-2 Interior Glazing Units.

Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-1	Vision glass, solar low-E insulating unit [Basis of Design Product: Viracon VE1-48] <u>Outdoor Lite:</u> Class 1 (clear) heat treated glass. Low-E Coating: Sputtered on second surface. <u>Interspace Content:</u> Air. Air <u>Indoor Lite:</u> Class 1 (clear) float glass.	Overall unit: 25mm. Each lite: 6.0mm.	37	0.31	0.29	0.31	0.19



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-2	<p>Vision glass, solar low-E insulating unit, tempered [Basis of Design Product: Viracon VE1-48]</p> <p><u>Outdoor Lite:</u></p> <p>Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾. Low-E Coating: Sputtered on second surface.</p> <p><u>Interspace Content:</u></p> <p>Air</p> <p><u>Indoor Lite:</u></p> <p>Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾.</p>	<p>Overall unit: 25mm. Each lite: 6.0mm.</p>	47	0.31	0.29	0.37	0.17



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-3	<p>Vision glass, solar low-E insulating unit with fire-rated laminated assembly. [Basis of Design Product: Guardian Industries Corp. LE 40]</p> <p><u>Outdoor Lite:</u></p> <p>Class 1 (clear) float glass. Low-E Coating: Applied on second surface.</p> <p><u>Interspace Content:</u></p> <p>Air</p> <p><u>Indoor Lite:</u></p> <p>Laminated glass with intumescent interlayers, Kind FT (fully tempered)⁽²⁾⁽⁵⁾, consisting of multiple lites. PVB layer on third surface. Fire rating⁽⁴⁾: 45 minutes.</p>	<p>Overall unit: 33mm nominal. Outdoor lite: 6.0mm. Indoor lite: 19mm.</p>	N/A	N/A	N/A	N/A	N/A



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-4	<p>Vision glass, solar low-E insulating unit with fire-rated laminated assembly, tempered [Basis of Design Product: Guardian Industries Corp. LE 40]</p> <p><u>Outdoor Lite:</u></p> <p>Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾ Low-E Coating: Sputtered on second surface.</p> <p><u>Interspace Content:</u></p> <p>Air.</p> <p><u>Indoor Lite:</u></p> <p>Laminated glass with intumescent interlayers, Kind FT (fully tempered)⁽²⁾⁽⁵⁾, consisting of multiple lites of annealed float glass. PVB layer on third surface. Fire rating⁽⁴⁾: 45 minutes.</p>	<p>Overall unit: 33mm nominal. Outdoor lite: 6.0mm. Indoor lite: 19mm.</p>	N/A	N/A	N/A	N/A	N/A



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-5	<p>Vision glass, solar low-E insulating unit, spandrel. [Basis of Design Product: Viracon VE1-48]</p> <p><u>Outdoor Lite:</u></p> <p>Class 1 (clear) float glass. Low-E coating: Sputtered on second surface.</p> <p><u>Interspace Content:</u></p> <p>Air.</p> <p><u>Indoor Lite:</u></p> <p>Coated spandrel float glass. Opacifier on fourth surface.</p>	<p>Overall unit: 25mm. Each lite: 6.0mm.</p>	N/A	N/A	N/A	N/A	N/A



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-6	<p>Vision glass, solar low-E insulating unit. [Basis of Design Product: Viracon VE1-2M]</p> <p><u>Outdoor Lite:</u> Class 1 (clear) float glass. Low-E Coating: Sputtered on second surface.</p> <p><u>Interspace Content:</u> Air.</p> <p><u>Indoor Lite:</u> Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾.</p>	<p>Overall unit: 32mm nominal. Outdoor lite: 6.0mm. Indoor lite: 13mm nominal.</p>	70	0.29	0.26	0.38	11



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-14	<p>Fritted low-E insulated exterior envelope glazing. [Basis of Design Product: Viracon VE1-48 screen #5102 #2 with V-933 Warm Grey Silkscreen #50% #2]</p> <p><u>Outdoor Lite:</u></p> <p>Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾. Low-E Coating: Applied on second surface. Silkscreen: Applied on second surface.</p> <p><u>Interspace Content</u></p> <p>Air</p> <p><u>Indoor Lite</u></p> <p>Class 1 (clear) float glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾.</p>	<p>Overall unit: 31.2mm nominal. Outdoor lite: 6.0mm. Indoor lite: 6.0mm nominal.</p>	26	0.31	0.29	0.25	16



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
GL-15	<p>Spandrel insulated exterior envelop glazing. [Basis of Design Product: Viracon VE1-48 #2 surface with V-948 medium grey full coverage #4 surface]</p> <p><u>Outdoor Lite</u></p> <p>Class 1 (clear) heat treated glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾. Coating: Applied on second surface.</p> <p><u>Interspace Content</u></p> <p>Air (with grey or black silicone).</p> <p><u>Indoor Lite</u></p> <p>Class 1 (clear) heat treated glass, Kind FT (fully tempered)⁽²⁾⁽⁵⁾. Coating: Applied on fourth surface.</p>	<p>Overall unit: 31.2mm nominal. Outdoor lite: 6.0mm. Indoor lite: 6.0mm nominal.</p>	N/A	N/A	N/A	N/A	N/A



Schedule 08800-1 Exterior Glazing Units ⁽¹⁾							
Designation	Description	Thickness ⁽³⁾ (mm)	Minimum Visible Light Transmittance (Percent)	Maximum U-Factor		Maximum Solar Heat Gain Coefficient	Maximum Outdoor Visible Reflectance (Percent)
				Winter Nighttime	Summer Daytime		
<div>1. Provide appropriate units at the locations on the Contract Drawings indicated by the Schedule 08800-2 designations.</div> <div>2. Provide units of the appropriate Kind as specified in ASTM C 1048.</div> <div>3. Provide units of the appropriate thickness as specified in ASTM E 1300.</div> <div>4. Provide units having the appropriate fire rating when tested as specified in NFPA 80 and NFPA 252 or NFPA 257 as appropriate.</div> <div>5. Provide units that have been heat-soak tested for a minimum of 2 hours at a temperature of 550 degrees Fahrenheit plus or minus 50 degrees Fahrenheit (290 degrees Celsius plus or minus 10 degrees Celsius).</div>							



Schedule 08800-2 Interior Glazing Units ⁽¹⁾				
Designation	Description	Kind ⁽²⁾	Thickness ⁽³⁾	Fire Rating ⁽⁴⁾
GL-7	Vision glass, clear: Annealed float glass	N/A	6.0mm	N/A
GL-8	Vision glass, clear: Annealed float glass	Kind FT	6.0mm	N/A
GL-8A	Vision glass, clear: Annealed float glass with frosted glass film	Kind FT	6.0mm	N/A
GL-9	Vision glass, clear: Annealed float glass	Kind FT	12.0mm	N/A
GL-9A	Vision glass, clear: Annealed float glass with frosted glazing film	Kind FT	12.0mm	N/A
GL-9B	Vision glass, clear: Annealed float glass with opaque glazing film	Kind FT	12.0mm	N/A
GL-10	Vision glass, clear: Laminated glass with multiple lites of annealed float glass	Kind FT	19.0mm	45 minutes
GL-11	Vision glass, clear: Laminated glass with multiple lites of annealed float glass having intumescent interlayers	Kind FT	40.0mm	120 minutes
GL-12	Vision glass, ultra-clear (low iron): Float glass	N/A	6.0mm	N/A
GL-13	Vision glass, clear: Laminated glass multiple lites of annealed float glass having intumescent interlayers	Kind FT	37.0mm	90 minutes
<ol style="list-style-type: none">1. Provide appropriate units at the locations on the Contract Drawings indicated by the Schedule 08800-2 designations.2. Provide units of the appropriate Kind as specified in ASTM C 1048.3. Provide units of the appropriate thickness as specified in ASTM E 1300.4. Provide units having the appropriate fire rating when tested as specified in NFPA 80 and NFPA 252 or NFPA 257 as appropriate.				





SECTION 08975

STRUCTURAL SEALANT GLAZED ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for factory-glazed, four-sided structural-sealant-glazed curtain-wall assemblies.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01360 - Sustainable Design Requirements.
 - 4. Section 01454 - Mock-Up Requirements.
 - 5. Section 01780 - Closeout Submittals.
 - 6. Section 07920 - Joint Sealants.
 - 7. Section 08411 - Aluminum-Framed Entrances and Storefronts.
 - 8. Section 08800 - Glazing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CD-R: Compact disc - read only.
 - 2. CR: Condensation Resistance.
 - 3. PVDF: Polyvinylidene fluoride, a highly non-reactive and pure thermoplastic fluoropolymer.
 - 4. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 5. SHGC: Solar Heat Gain Coefficient.
 - 6. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. British Thermal Unit or Btu: A measure of energy defined as the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
 - 3. U-Factor: The overall heat transfer coefficient, U, for some area, A, is defined by the equation $q = UA(t_1 - t_2)$, where the $(t_1 - t_2)$ term represents



the temperature difference between the surfaces of a solid wall, and q is the steady state heat transfer from one fluid to another through the wall.

C. Reference Standards:

1. American Architectural Manufacturer's Association (AAMA):
 - a. AAMA 501.1 – Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
 - b. AAMA 501.2 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
 - c. AAMA 501.5 – Test Method for Thermal Cycling of Exterior Walls.
 - d. AAMA 2605 - Voluntary Specifications, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
3. American Welding Society (AWS):
 - a. AWS A5.10/A5.10M – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
 - b. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - c. AWS D1.2/D1.2M - Structural Welding Code-Aluminum.
4. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. ASTM A 240/A 240M – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - e. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - f. ASTM A 1011/A 1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - g. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - h. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].



- i. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- j. ASTM B 221M – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- k. ASTM B 308/B 308M – Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- l. ASTM B 429/B 429M – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- m. ASTM C 920 – Standard Specification for Elastomeric Joint Sealants.
- n. ASTM C 1184 – Standard Specification for Structural Silicone Sealants.
- o. ASTM C 1401 – Standard Guide for Structural Sealant Glazing.
- p. ASTM D 2244 – Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- q. ASTM D 4214 – Standard Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
- r. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- s. ASTM E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- t. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- u. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- v. ASTM E 699 - Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- w. ASTM E 783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors [*withdrawn 2002*].
- x. ASTM E 1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- y. ASTM E 1332 – Standard Classification for Determination of Outdoor-Indoor Transmission Class.
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. ICC Evaluation Service, Inc. (ICC ES), <http://www.icc-es.org/reports/index>:
- 7. International Code Council (ICC):



- a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
8. International Organization for Standardization/International Electrotechnical Commission (ISO/IEC):
 - a. ANSI/ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories.
9. National Fenestration Rating Council Incorporated (NFRC):
 - a. NFRC 100 - Procedure for Determining Fenestration Product U-Factors.
 - b. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - c. NFRC 500 – Procedure for Determining Fenestration Product Condensation Resistance Values.
10. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
11. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-PS Guide 12.00 – Guide to Zinc-Rich Coating Systems.
 - 2) SSPC-Paint 33 – Coal Tar Mastic, Cold Applied.
 - 3) SSPC-SP COM – Surface Preparation Commentary for Steel and Concrete Substrates.
12. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Preconstruction Testing Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Notify Program/Project Manager 7 days in advance of the dates and times when the laboratory mockups for Contract-specific preconstruction testing will be constructed.
 2. Coordinate the structural sealant glazed system fabrication schedule with construction progress so delays to the Work are avoided.
- B. Pre-Installation Meetings:
 1. Prior to the start of the structural sealant glazed system installation, convene a meeting at the Site in accordance with the requirements specified in Section 01316, Project Meetings, to review areas of potential interference and conflicts with the installers of other Work, and to review



Special Inspections that may be required by the Phoenix Building Construction Code and Amendments and ICC International Building Code (IBC) as Amended by the City of Phoenix.

C. Scheduling:

1. Time the delivery of structural sealant glazed system materials to the Site to ensure uninterrupted progress of the installation Work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Glazing.
 - 2) Glazing gaskets, spacers, setting blocks, sealant backings, and bond breakers.
 - 3) Glazing sealants.
 - 4) Framing Members.
 - a) Aluminum.
 - b) Steel reinforcement.
 - c) Fasteners and accessories.
 - d) Anchors.
 - e) Concealed flashing.
 - f) Framing sealants.
 - 5) Operable units.
 - b. Shop Drawings:
 - 1) Structural-sealant-glazed curtain wall system.
 - c. Samples:
 - 1) Color finishes for Initial selection.
 - 2) Exposed finishes for verification of the finishes.
 - 3) Fabrication Samples.
 - d. Certificates:
 - 1) Seismic Qualification Certificates.
 - e. Delegated Design Submittals:
 - 1) Structural-sealant-glazed curtain wall system design.
 - f. Special Procedure Submittals:
 - 1) Preconstruction Testing Program.
 - g. Qualification Statements:
 - 1) Welding procedure specifications (WPS) test records.
 - 2) Welding Certificates.
 - 3) Preconstruction Testing Agency's qualifications.
 - 4) Professional Engineer's credentials.
 - 5) Structural sealant glazed assembly installer's qualifications.
 - 6) Approved by manufacturer for installation of sun shade system.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Product Test Reports from the Preconstruction Testing Agency.
 - 2) Preconstruction Test Reports from the Preconstruction Testing Agency.
 - b. Source Quality Control Submittals:
 - 1) Quality-Control Program for the fabrication and installation of structural sealant glazed assemblies.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the structural-sealant-glazed curtain walls.
 - b. Warranty Documentation:
 - 1) Structural Sealant Glazed Assembly Warranty.
 - 2) Structural Sealant Glazed Assembly Finish Warranty.
 - c. Record Documentation:
 - 1) Preconstruction mockup photographs.
 - 2) Preconstruction mockup record drawings.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections, the Phoenix Sky Harbor International Airport will employ both the City of Phoenix Testing Laboratory and an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements, and qualified in accordance with the requirements specified in ASTM E 699 for the testing required.
2. Preconstruction Testing Agency's Qualifications:
 - a. Engage a Preconstruction Testing Agency qualified according to the requirements specified in ANSI/ISO/IEC 17025 to perform preconstruction testing on laboratory mockups, and accredited by the ICC Evaluation Service, Inc. (ICC ES) for the preconstruction testing specified.



- b. Submit the Preconstruction Testing Agency's qualifications to the Program/Project Manager for approval.
 3. Professional Engineer's Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform the comprehensive engineering analysis required for the structural sealant glazed assemblies.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.
 4. Structural Sealant Glazed Assembly Installer's Qualifications:
 - a. Employ an installer that is an authorized representative of the manufacturer of the structural sealant glazed assemblies, and that is trained and approved for installation of the type of units required for this Contract.
 - b. Submit the structural sealant glazed assembly installer's qualifications to the Program/Project Manager for approval.
 5. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.2/D1.2M, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures AWS D1.1/D1.1M and AWS D1.2/D1.2M.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

B. Certifications:

1. Energy-Performance Certificates:



- a. Provide structural-sealant-glazed curtain walls having energy performance ratings certified and labeled in accordance with the requirements of the National Fenestration Rating Council Incorporated (NFRC).
 - 1) For each structural-sealant-glazed curtain wall, have the manufacturer attach a label on the structural-sealant-glazed curtain walls, accessories, and components listing the National Fenestration Rating Council Incorporated (NFRC) certified energy-performance values for the item.
- 2. Seismic Qualification Certificates:
 - a. Prepare Seismic Qualification Certificates certifying that the structural sealant glazed curtain walls, accessories, and components will withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
 - 3) Include a detailed description of the anchorage devices on which the certification is based, and their installation requirements.
 - b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.
- C. Preconstruction Testing:
 - 1. Provide structural-sealant-glazed curtain walls that comply with the performance/test requirements indicated in Paragraph 2.01.C, as evidenced by reports based on Contract-specific preconstruction testing by a qualified Preconstruction Testing Agency.
 - 2. Build laboratory mockups at the Preconstruction Testing Agency facility in accordance with the requirements specified in Section 01454, Mock-Up Requirements, using the personnel, materials, and methods of construction that will be used at the Site.
 - 3. Preconstruction Testing Program:
 - a. Develop a Preconstruction Testing Program specifically for this Contract.
 - 1) Submit the Preconstruction Testing Program to the Program/Project Manager for approval.
 - b. Perform the performance tests specified in Paragraph 2.01.C on the laboratory mockups in the following order:
 - 1) Structural-performance preloading at 50 percent of the specified wind-load design pressure when measured in accordance with the method specified in ASTM E 330.
 - 2) Air infiltration when measured in accordance with the method specified in ASTM E 283.



- 3) Water penetration under static pressure when measured in accordance with the method specified in ASTM E 331.
- 4) Water penetration under dynamic pressure when measured in accordance with the method specified in AAMA 501.1.
- 5) Structural performance at the design load when measured in accordance with the method specified in ASTM E 330.
- 6) Repeat the air filtration test measured in accordance with the method specified in ASTM E 283.
- 7) Repeat the water penetration test under static pressure measured in accordance with the method specified in ASTM E 331.
- 8) Structural performance at maximum 150 percent of positive and negative wind-load design pressures when measured in accordance with the method specified in ASTM E 330.
- c. Preconstruction Sealant Testing:
 - 1) Perform the sealant manufacturer's standard tests for compatibility with and adhesion of each material that will come in contact with sealants and each condition.
 - a) Test a minimum of 5 production-run samples each of metal, glazing, and other material.
 - b) Prepare the samples using the techniques and primers required for the installed assemblies.
 - c) Perform tests under environmental conditions that duplicate those under which the assemblies will be installed.
 - d) For materials that fail tests, determine the corrective measures necessary to prepare each material to ensure compatibility with and adhesion of the sealants, including, but not limited to, specially formulated primers.
 - (1) After performing these corrective measures on the minimum number of samples required for each material, retest the materials.
4. Preconstruction Test Reports:
 - a. For structural-sealant-glazed curtain walls and elastomeric glazing sealants, have the qualified Preconstruction Testing Agency submit Preconstruction Test Reports for each mockup test directly to the Program/Project Manager for information.
5. Preconstruction Mockup Photographs:
 - a. Take a minimum of 30 photographs at locations and intervals as directed by the Program/Project Manager.
 - 1) Submit high-resolution digital color images on CD-R of the mockup before, during, and after the preconstruction testing.
6. Preconstruction Mockup Record Drawings:
 - a. Have the Preconstruction Testing Agency prepare record drawings of the preconstruction mockups.
 - b. Submit the Preconstruction Mockup Record Drawings to the Program/Project Manager for information.



- D. Site Samples:
 - 1. Samples for Initial Selection:
 - a. For units with factory-applied color finishes, submit Samples of the color finishes for Initial selection of the finishes.
 - 2. Samples for Verification:
 - a. For each type of exposed finish required, submit 12-inch Samples of the exposed finish required and of the manufacturer's standard sizes for verification of the finish.
- E. Mock-Ups:
 - 1. Build mockups to verify the selections made from Sample submittals, to demonstrate the aesthetic effects, and set the quality standards for fabrication and installation.
 - a. Build mockups of a typical wall area as shown on the Contract Drawings.
 - b. Perform field testing on mockups in accordance with the requirements in Article 3.05.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in the mockups unless the Program/Project Manager specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if they are undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Crate and ship the glass and structural steel components so they will be unscratched and undamaged when they are delivered to the Site.
 - 2. Upon delivery of the metal components, check them for dents, gouges, or other imperfections which may result in rejection of the appearance or reduce the strength of the structural glass curtain walls.
 - 3. Upon delivery of the glass panels, check them for scratches, imperfections, and edge damage.
 - a. Do not install damaged glass.
- B. Storage and Handling Requirements:
 - 1. Only lift structural sealant glazed assemblies at connections approved by the system's design engineer.
 - a. Handle, lift, and align pieces using padded slings, suction cups, and/or other protection required to maintain the appearance of the system throughout the installation process.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



1.07 WARRANTY

- A. Structural Sealant Glazed Assembly Warranty:
 - 1. Warrant the structural sealant glazed assembly against defects within the 10-year period after the Date of Substantial Completion:
 - a. Submit a Structural Sealant Glazed Assembly Warranty on the structural sealant glazed assembly manufacturer's standard or customized form, without monetary limitation, in which the structural sealant glazed assembly manufacturer agrees to replace structural sealant glazed assemblies that do not comply with requirements or that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.
 - b. Failures include, but are not limited to, the following:
 - 1) Structural failures including, but not limited to, excessive deflection.
 - 2) Noise or vibration created by wind and thermal and structural movements.
 - 3) Deterioration of metals and other materials beyond normal weathering.
 - 4) Water penetration through fixed glazing and framing areas.
 - 5) Failure of operating components.
- B. Structural Sealant Glazed Assembly Finish Warranty:
 - 1. Warrant the structural sealant glazed assembly finishes against defects within the 20-year period after the Date of Substantial Completion:
 - a. Submit a Structural Sealant Glazed Assembly Finish Warranty on the structural sealant glazed assembly manufacturer's standard or customized form, without monetary limitation, in which the structural sealant glazed assembly manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within the specified warranty period to the Program/Project Manager for approval.
 - b. Deterioration includes, but is not limited to, the following:
 - 1) Color fading more than 5 Hunter units when measured in accordance with the method specified in ASTM D 2244.
 - 2) Chalking in excess of a No. 8 rating when measured in accordance with the method specified in ASTM D 4214.
 - 3) Cracking, checking, peeling, or failure of the paint to adhere to the bare metal.

PART 2 PRODUCTS

2.01 STRUCTURAL SEALANT GLAZED ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the following manufacturers:
 - 1) Arcadia, Inc., <http://www.arcadiaincorporated.com>.
 - 2) Arch Aluminum & Glass Co., Inc., <http://www.archaluminum.net>.
 - 3) EFCO Corporation, <http://www.efcocorp.com>.
 - 4) Kawneer North America; an Alcoa company, <http://www.kawneer.com>.
 - 5) United States Aluminum, <http://www.usalum.com>.
 - 6) Vistawall Architectural Products, Oldcastle Glass Engineered Products, <http://www.vistawall.com>.
 - 7) Wausau Window and Wall Systems, <http://www.wausauwindow.com>.
 - 8) Walters and Wolf, Inc., <http://www.waltersandwolf.com>
 - 9) Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 2. Sustainable Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Architectural Sealants: Not more than 250 grams per Liter less water.
- C. Performance:
1. Provide structural sealant glazed assemblies complying with the performance requirements specified herein, as established by preconstruction testing performed successfully on structural-sealant-glazed curtain wall mock-ups representing the structural-sealant-glazed curtain walls to be constructed under this Section without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - a. The structural-sealant-glazed curtain walls must withstand movements of the supporting structure, including but not limited to, story drift,



twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

- b. Failures also include the following conditions:
 - 1) Thermal stresses transferred to the building structure.
 - 2) Glass breakage.
 - 3) Noise or vibration created by wind and by thermal and structural movements.
 - 4) Loosening or weakening of fasteners, attachments, and other components.
 - 5) Failure of operating units.
- 2. Structural Loads:
 - a. Provide structural sealant glazed assemblies capable of withstanding the following structural loading:
 - 1) Wind Loads:
 - a) Basic Wind Speed: 120 mph (40m/s).
 - b) Internal pressure Coefficient: $GC (pi) = 0.18 +/-$.
 - c) Exposure Category: C.
 - d) Components and Cladding Wind Pressure: As required by Chapter 30 of ASCE 7-10.
 - 2) Periodic Maintenance-Equipment Loads:
 - a) As indicated on the Contract Drawings.
 - b. Allowable Deflection of Framing Members at Design Wind Pressure:
 - 1) Deflection Normal to the Wall Plane:
 - a) The deflection is limited to $1/175$ of the clear span for spans up to 13 feet 6 inches (4.1m), and to $1/240$ of the clear span plus $1/4$ inch (6.35mm) for spans greater than 13 feet 6 inches (4.1m), or an amount that restricts the edge deflection of individual glazing lites to $3/4$ inch (19mm), whichever is less.
 - 2) Deflection Parallel to the Glazing Plane:
 - a) The deflection is limited to $L/360$ of the clear span, or $1/8$ inch (3.2mm), whichever is smaller.
 - b) Provide a minimum clearance of $1/16$ inch (1.6mm) between the framing members and operable units.
 - 3) Cantilever Deflection:
 - a) Where framing members overhang an anchor point, the deflection is limited to 2 times the length of the cantilevered member divided by 175.
 - c. Structural-Test Performance:
 - 1) Test Procedure:
 - a) Tested the structural-sealant-glazed curtain walls in accordance with the method specified in ASTM E 330.
 - b) Test Duration:
 - (1) Perform the test as required by the design wind velocity, but not less than 90 seconds.
 - 2) Acceptance Criteria:



- a) When tested at positive and negative wind-load design pressures, the assemblies cannot evidence deflection exceeding the specified limits.
 - b) When tested at 150 percent of positive and negative wind-load design pressures, the assemblies including anchorage cannot evidence material failures, structural distress, and permanent deformation of the main framing members exceeding 0.2 percent of the span.
3. Seismic Performance:
 - a. Provide structural-sealant-glazed curtain walls capable of withstanding the effects of earthquake motions determined in accordance with the method specified in ASCE/SEI 7 using a component importance factor of 1.5.
4. Water Penetration under Static Pressure:
 - a. Test Procedure:
 - 1) Test the water penetration of the structural-sealant-glazed curtain walls under static pressure in accordance with the methods specified in ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 pounds per square foot (720Pa).
 - b. Acceptance Criteria:
 - 1) The structural-sealant-glazed curtain walls must show no evidence of water penetration through the fixed glazing and framing areas.
5. Water Penetration under Dynamic Pressure:
 - a. Test Procedure:
 - 1) Test the water penetration of the structural-sealant-glazed curtain walls under dynamic pressure in accordance with the methods specified in AAMA 501.1 at a dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 pounds per square foot (720Pa).
 - b. Acceptance Criteria:
 - 1) The structural-sealant-glazed curtain walls must show no evidence of water penetration through the fixed glazing and framing areas.
 - a) Water penetration is defined as uncontrolled water penetrating the assemblies, or water appearing on the normally exposed interior surfaces of the assemblies from sources other than condensation.
 - b) Water controlled by flashing and gutters that is drained to the exterior is not considered to be water leakage.
 - c) Up to 1/2 ounce. (15mL) of water may accumulate on an interior stop or stool integral to the assembly in a 15 minute period without causing the assembly to fail the test.
6. Thermal Movements:



- a. Provide structural-sealant-glazed curtain walls capable of accommodating thermal movements resulting from the following maximum changes (range) in ambient and surface temperatures:
 - 1) Temperature Change (Range): 120 degrees Fahrenheit (67 degrees Celsius), ambient; 180 degrees Fahrenheit (100 degrees Celsius), material surfaces.
 - 2) Test Interior Ambient-Air Temperature: Minimum 70 degrees Fahrenheit, maximum 75 degrees Fahrenheit (24 degrees Celsius).
- b. Test Procedure:
 - 1) Test the thermal movements of the structural-sealant-glazed curtain walls in accordance with the methods specified in AAMA 501.5.
- c. Acceptance Criteria:
 - 1) The structural-sealant-glazed curtain walls must show no buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance.
- 7. Energy-Performance Standards:
 - a. For minimum standards of energy performance, materials, components, accessories, and fabrication, comply with the requirements specified by the National Fenestration Rating Council Incorporated (NFRC).
 - 1) If more stringent requirements are indicated in the Contract Documents, comply with the more stringent requirements.
 - b. Thermal Transmittance (U-Factor):
 - 1) Provide structural sealant glazed assemblies having thermal transmittance (U-factor) through the fixed glazing and framing areas of not more than 0.45 Btu per square foot per hour degree Fahrenheit ($2.55\text{W/m}^2/\text{K}$) when measured in accordance with the method specified in NFRC 100.
 - c. Solar Heat Gain Coefficient (SHGC):
 - 1) Provide structural sealant glazed assemblies having a solar heat gain coefficient (SHGC) through the fixed glazing and framing areas not greater than 0.40 when measured in accordance with the method specified in NFRC 200.
 - d. Air Infiltration:
 - 1) Provide structural sealant glazed assemblies having maximum air leakage through the fixed glazing and framing areas at a minimum static-air-pressure differential of 6.24 pounds-force per square foot (300 Pa) of 0.06 cubic feet per minute per square foot of fixed wall area when measured in accordance with the method specified in ASTM E 283.
 - e. Condensation Resistance (CR):
 - 1) Provide structural sealant glazed assemblies having a National Fenestration Rating Council Incorporated (NFRC) certified



- condensation resistance (CR) through the fixed glazing and framing areas of not less than 55 when measured in accordance with the method specified in NFRC 500.
8. Sound Transmission:
 - a. Provide structural sealant glazed assemblies having a minimum Outdoor-Indoor Sound Transmission Class through the fixed glazing and framing areas of 25 when the laboratory sound transmission loss is measured in accordance with the method specified in ASTM E 90 and determined by the method specified in ASTM E 1332.
 9. Structural Sealant:
 - a. Provide structural sealant capable of withstanding the tensile and shear stresses imposed by the structural-sealant-glazed curtain walls without failing adhesively or cohesively.
 - 1) Adhesive failure occurs when the sealant pulls away from the substrate cleanly, leaving no sealant material behind.
 - 2) Cohesive failure occurs when the sealant breaks or tears within itself, but does not separate from each substrate because the sealant-to-substrate bond strength exceeds sealant's internal strength.
 - b. When the structural sealant is tested for preconstruction adhesion and compatibility, cohesive failure of sealant must occur before adhesive failure.
- D. Design Criteria:
1. The information furnished in the Contract Documents establishes the requirements for the assemblies' aesthetic effects and performance characteristics.
 - a. The aesthetic effects are indicated by the dimensions, arrangements, alignment, and profiles of the components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - b. Do not revise the intended aesthetic effects, as judged solely by the Program/Project Manager, except with the Program/Project Manager's written approval.
 - 1) If revisions are proposed, submit comprehensive explanatory data to Program/Project Manager for review.
 2. Delegated Design:
 - a. Design the structural-sealant-glazed curtain walls, including having a qualified Professional Engineer perform a comprehensive engineering analysis, to comply with the performance requirements and design criteria specified in this Section.
 - b. Structural Sealant Glazed Curtain Wall System Design Submittal:
 - 1) Submit the structural-sealant-glazed curtain wall system design, including the analysis data signed and sealed by the qualified Professional Engineer responsible for its preparation, to the Program/Project Manager for approval.



- 2) Have the design reviewed and approved by the structural-sealant manufacturer.
3. Structural-Sealant Glazing:
 - a. Provide structural sealant glazing complying with the requirements for design and installation of structural-sealant-glazed curtain walls specified in ASTM C 1401.
 - b. Provide glazing having a minimum frame bite of 3/8 inches.
4. Structural-Sealant Joints:
 - a. Provide structural sealant joints designed to carry the gravity loads of the glazing.
 - b. Provide structural sealant joints designed produce tensile or shear stresses of less than 20 psi (138kPa).
5. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of product specified, including construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - b. Submit the Product Data to the Program/Project Manager for approval.
6. Shop Drawings:
 - a. Prepare Shop Drawings for the structural-sealant-glazed curtain wall system, including plans, elevations, sections, full-size details, and attachments to other work.
 - 1) Include details of expansion and contraction provisions for the assembly, and provisions for draining moisture occurring within the assembly to the exterior.
 - 2) For each vertical-to-horizontal intersection of the structural sealant glazed curtain walls, include full-size isometric details showing the following:
 - a) Joinery, including concealed welds.
 - b) Anchorage.
 - c) Expansion provisions.
 - d) Glazing.
 - e) Flashing and drainage.
 - 3) Include laboratory mockup Shop Drawings, prepared by the qualified Preconstruction Testing Agency, showing details of the laboratory mockup.
 - a) Resubmit the laboratory mockup Shop Drawings if changes are made to the details of the structural-sealant-glazed curtain walls in order to successfully complete the preconstruction testing.
7. Product Test Reports:
 - a. Based on evaluation of the comprehensive tests performed by the qualified Preconstruction Testing Agency, have the Preconstruction Testing Agency submit Product Test Reports for the structural sealant



glazed curtain walls, indicating compliance with the performance requirements, to the Program/Project Manager for information.

E. Materials:

1. Glazing:

- a. Unless otherwise indicated in the Contract Drawings, provide glazing complying with the requirements for the glazing specified in Section 08800, Glazing.

2. Glazing Gaskets, Spacers, Setting Blocks, Sealant Backings, and Bond Breakers:

- a. Provide the manufacturer's standard permanent, non-migrating types of glazing gaskets, spacers, setting blocks, sealant backings, and bond breakers compatible with the sealants, and suitable for joint movement and assembly performance requirements.

3. Glazing Sealants:

- a. Provide glazing sealants for the structural sealant glazed curtain walls as recommended by the structural sealant glazed curtain wall manufacturer for the joint type, and as follows:

1) Structural Sealant:

- a) Provide structural sealant complying with the requirements specified in ASTM C 1184

- (1) Provide a chemically curing silicone formulation that is compatible with the system components with which it comes in contact.

- (2) Provide structural sealant specifically formulated and tested for use as a structural sealant, and approved by the structural-sealant manufacturer for use in the curtain wall assembly specified.

- b) Color:

- (1) Provide structural sealant colors as selected by the Program/Project Manager from the manufacturer's full range of colors

2) Weatherseal Sealant:

- a) Provide weatherseal sealant complying with the requirements for Type S; Grade NS; Class 25 sealant specified in ASTM C 920 for Uses NT, G, A, and O.

- (1) Provide a chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact.

- (2) Provide a weatherseal sealant recommended by the structural sealant, weatherseal sealant, and structural sealant glazed curtain-wall manufacturers for this use.

- b) Color:

- (1) Provide weatherseal sealant having a color matching the structural sealant color.

4. Framing:



- a. Framing Members:
 - 1) Provide the manufacturer's standard formed-aluminum or extruded-aluminum framing members having the thickness required and reinforced as required to support the imposed loads.
 - 2) Aluminum:
 - a) Provide aluminum of the alloy and temper recommended by the structural sealant glazed curtain walls manufacturer for type of use and finish indicated in the Contract Documents.
 - (1) Sheet and Plate:
 - (a) Provide aluminum sheet and plate complying with the requirements specified in ASTM B 209 (ASTM B 209M).
 - (2) Extruded Bars, Rods, Profiles, and Tubes:
 - (a) Provide extruded aluminum bars, rods, profiles, and tubes complying with the requirements specified in ASTM B 221 (ASTM B 221M).
 - (3) Extruded Structural Pipe and Tubes:
 - (a) Provide extruded aluminum structural pipe and tubes complying with the requirements specified in ASTM B 429/B 429M.
 - (4) Structural Profiles:
 - (a) Provide aluminum structural profiles complying with the requirements specified in ASTM B 308/B 308M.
 - (5) Welding Rods and Bare Electrodes:
 - (a) Provide welding rods and bare electrodes for welding aluminum complying with the requirements specified in AWS A5.10/A5.10M.
 - 3) Steel Reinforcement:
 - a) Provide steel for reinforcement having the manufacturer's standard zinc-rich, corrosion-resistant primer complying with the requirements specified in SSPC-PS Guide 12.00.
 - (1) Apply the primer immediately after surface preparation and pretreatment of the steel.
 - (2) Select surface preparation methods in accordance with the recommendations in SSPC-SP COM, and prepare the surfaces according to applicable SSPC standard.
 - b) Structural Shapes, Plates, and Bars:
 - (1) Provide steel structural shapes, plates, and bars complying with the requirements specified in ASTM A 36/A 36M.
 - c) Cold-Rolled Sheet and Strip:
 - (1) Provide steel cold-rolled sheet and strip complying with the requirements specified in ASTM A 1008/A 1008M.
 - d) Hot-Rolled Sheet and Strip:



- (1) Provide steel hot-rolled sheet and strip complying with the requirements specified in ASTM A 1011/A 1011M.
 - b. Fasteners and Accessories:
 - 1) Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - 2) Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, provide self-locking devices.
 - 3) Reinforce members as required for receiving fastener threads.
 - 4) Provide exposed fasteners having countersunk Phillips screw heads finished to match the framing system or fabricated from Series 300 stainless steel.
 - c. Anchors:
 - 1) Provide three-way adjustable anchors having a minimum adjustment of 1 inch (25.4mm) to accommodate fabrication and installation tolerances in the material and finish, and that are compatible with the adjoining materials and recommended by the structural sealant glazed curtain wall manufacturer.
 - 2) Concrete and Masonry Inserts:
 - a) Provide hot-dip galvanized cast-iron, malleable-iron, or steel inserts for concrete and masonry complying with the requirements specified in ASTM A 123/A 123M or ASTM A 153/A 153M.
 - d. Concealed Flashing:
 - 1) Provide the manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials, or dead-soft, 0.018-inch (0.457mm) thick stainless-steel flashing, complying with the requirements specified in ASTM A 240/A 240M and of a type recommended by the structural sealant glazed curtain wall manufacturer.
 - e. Framing Sealants:
 - 1) Provide the structural sealant glazed curtain wall manufacturer's standard sealants.
 5. Operable Units:
 - a. Doors:
 - 1) Provide doors complying with the requirements specified in Section 08411, Aluminum-Framed Entrances and Storefronts.
- F. Fabrication:
1. Form or extrude aluminum shapes before finishing them.
 2. Perform welds in concealed locations to greatest extent possible to minimize distortion or discoloration of the finish.
 - a. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.



3. Fabricate components so they have the following characteristics when they have been assembled:
 - a. Sharp, straight, profiles that are free of defects or deformations.
 - b. Accurately fitted joints having coped or mitered ends.
 - c. Glazing physically and thermally isolated from framing members.
 - d. Accommodation of thermal and mechanical movements of the glazing and framing to maintain the required glazing edge clearances.
 - e. Fasteners, anchors, and connection devices concealed from view to greatest extent possible.
 - f. Provisions for field replacement of the glazing from the exterior.
 - 1) Include accommodations for using temporary support devices (dutchman) to retain the glazing in place while the sealant cures.
 - g. Provisions mounting safety railings independently of the mullions.
 - h. Components curved to the radii indicated in the Contract Documents.
 - i. Internal guttering systems or other means to drain the water passing joints, condensation occurring within framing members, and moisture migrating within the structural sealant glazed curtain wall to the exterior.
4. Factory-Assembled Frame Units:
 - a. Rigidly secure non-movement joints.
 - b. Prepare surfaces that will contact the structural sealant in accordance with the sealant manufacturer's written instructions to ensure compatibility and adhesion.
 - 1) Preparation includes, but is not limited to, cleaning and priming the surfaces.
 - c. Unless otherwise indicated, seal joints so they are watertight.
 - d. Install glazing in accordance with the requirements specified in Section 08800, Glazing.
5. After fabrication, clearly mark the structural sealant glazed curtain wall components to identify their locations in the Work in accordance with the Shop Drawings.

G. Finishes:

1. Primer Materials:
 - a. Provide the high-performance organic finish manufacturer's specially formulated inhibitive primer.
2. Finish Materials:
 - a. Bituminous Paint:
 - 1) Provide cold-applied, coal tar mastic complying with the requirements specified in SSPC-Paint 33.
 - b. High-Performance Organic Finish:
 - 1) Provide a 3-coat fluoropolymer finish complying with the requirements specified in AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both the color coat and the clear topcoat.



- 2) Provide the color and gloss as selected by the Program/Project Manager from the manufacturer's full range.
3. Shop Finishing Methods:
 - a. Aluminum:
 - 1) Prepare, pretreat, and apply the high-performance organic coating to exposed metal surfaces in accordance with the coating and resin manufacturers' written instructions.

2.02 ACCESSORIES

- A. Cleaning Agent and Cloth:
 1. Provide the cleaning agent and cloths recommended by the structural sealant manufacturer.

2.03 SOURCE QUALITY CONTROL

- A. Manufacturer Services:
 1. Quality-Control Program:
 - a. Develop a Quality-Control Program specifically for the fabrication and installation of structural sealant glazed assemblies for this Project in accordance with the recommendations in ASTM C 1401.
 - 1) Perform the quality control procedures in accordance with the recommendations in ASTM C 1401, including but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.
 - 2) Prepare and maintain source quality control reports.
 - b. Submit the Quality-Control Program for the fabrication and installation of structural sealant glazed assemblies to the Program/Project Manager for information.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the structural sealant glazed assembly installer present, examine the areas and conditions where the structural sealant glazed assemblies will be installed for compliance with the requirements for installation tolerances and other conditions affecting the performance of the Work.
 2. Field Measurements:
 - a. Verify the actual locations of the structural supports for the structural sealant glazed curtain walls by taking field measurements before fabricating the structural sealant glazed curtain walls and include the measurements on the Shop Drawings.
- B. Evaluation and Assessment:



1. Proceed to install the structural sealant glazed curtain walls only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the structural sealant glazed assemblies.
- B. Surface Preparation:
 1. Provide connections for temporary shoring, bracing, and supports as noted on the installation drawings.

3.03 INSTALLATION

- A. Erect the structural sealant glazed curtain wall framing structure, structural glazing, and accessory items in strict accordance with the approved Shop Drawings, Installation Drawings, and installation procedures.
 1. Comply with the structural sealant glazed curtain wall manufacturer's written instructions.
 2. Do not install damaged components.
 3. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of the joints.
 4. Fit joints to produce hairline joints free of burrs and distortion.
 5. Rigidly secure nonmoving joints.
 6. Weld components in concealed locations to minimize distortion or discoloration of the finish.
 - a. Protect glazing surfaces from welding damage.
 7. Unless otherwise indicated in the installation instructions, seal the joints so they are watertight.
- B. Metal Protection:
 1. Where aluminum will contact dissimilar metals, paint the contacting surfaces with primer, apply sealant or tape, or install nonconductive spacers to protect against galvanic action as recommended by the manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, paint the contacting surfaces with bituminous paint to protect against corrosion.
- C. Install components so water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain walls will be drained to the exterior.
- D. Install components plumb and true in alignment with established lines and grades.



- E. Install operable units level and plumb, securely anchored, and without distortion.
 - 1. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install the glazing as specified in Section 08800, Glazing.
 - 1. Prepare surfaces that will contact structural sealant in accordance with the sealant manufacturer's written instructions to ensure compatibility and adhesion.
 - a. Preparation includes, but is not limited to, cleaning and priming the surfaces.
- G. Install weatherseal sealant in accordance with the requirements specified in Section 07920, Joint Sealants, and in accordance with the sealant manufacturer's written instructions to produce weatherproof joints.
 - 1. Install joint filler behind the sealant as recommended by the sealant manufacturer.
- H. Tolerances:
 - 1. Erection Tolerances:
 - a. Install the structural sealant glazed curtain walls in accordance with the following non-accumulating maximum tolerances:
 - 1) Plumb: 1/8 inch in 10 feet (3mm in 3m).
 - 2) Level: 1/8 inch in 20 feet (3mm in 6m).
 - 3) Alignment:
 - a) Where surfaces abut in line or are separated by a reveal or protruding element up to 1/2 inch (12.7mm) wide, limit the offset from true alignment to 1/16 inch (1.6mm).
 - b) Where surfaces are separated by a reveal or protruding element from 1/2 inch to 1 inch (12.7mm to 25.4mm) wide, limit the offset from true alignment to 1/8 inch (3.2mm).
 - c) Where surfaces are separated by a reveal or protruding element of 1 inch (25.4mm) wide or more, limit the offset from true alignment to 1/4 inch (6mm).
 - 4) Location: Limit the variation from plane to 1/8 inch in 12 feet (3mm in 3.7m), and 1/2 inch (12.7mm) over the total length.

3.04 SITE QUALITY CONTROL

- A. During the period when structural sealant glazed assemblies are being installed, the Testing and Inspection Agency must perform routine and other testing of materials as installation proceeds to determine compliance of the installed assemblies with the specified requirements.
 - 1. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.



2. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
3. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

B. Site Tests and Inspections:

1. Structural-Sealant Adhesion Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will test the structural sealant in accordance with the recommendations of Destructive Test Method A, "Hand Pull Tab (Destructive)," in Appendix X2 of ASTM C 1401.
 - 2) A minimum of 6 areas on each building façade will be tested.
 - 3) Repair installed areas damaged by the testing.
 - b. Acceptance Criteria:
 - 1) Structural sealant that adheres as specified pass the Structural-Sealant Adhesion Test.
2. Air Infiltration Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will test areas for air leakage in accordance with the requirements specified in ASTM E 783 at a minimum static-air-pressure differential of 6.24 pounds-force per square foot (300 Pa).
 - 2) Test Area:
 - a) The Testing and Inspection Agency will test an area 1 bay wide, but not less than 30 feet (9.1m), by 1 story of structural sealant glazed curtain wall.
 - 3) A minimum of 3 tests will be performed in the areas as directed by the Program/Project Manager.
 - b. Acceptance Criteria:
 - 1) Structural sealant glazed assemblies having air infiltration less than 1.5 times the rate specified for laboratory testing in Subparagraph 2.01.C.8.d, but not more than 0.50 cubic feet per minute per square foot (2.25L/s/m²) of fixed wall area pass the Air Infiltration Test
3. Water Penetration Test:
 - a. Test Procedure:
 - 1) The Testing and Inspection Agency will test areas for water penetration in accordance with the requirements specified in ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential



- specified for laboratory testing in Subparagraphs 2.01.C.5.a.1 and 2.01.C.6.a.1, but not less than 6.24 pounds-force per square foot (300 Pa).
- 2) Test Area:
 - a) The Testing and Inspection Agency will test an area 1 bay wide, but not less than 30 feet (9.1m), by 1 story of structural sealant glazed curtain wall.
 - 3) A minimum of 3 tests will be performed in the areas as directed by the Program/Project Manager.
 - b. Acceptance Criteria:
 - 1) Structural sealant glazed assemblies that do not evidence water penetration pass the Water Penetration Test.
4. Water Spray Test:
- a. Test Procedure:
 - 1) Before installation of interior finishes has begun, the Testing and Inspection Agency will test areas designated by the Program/Project Manager in accordance with the requirements specified in AAMA 501.2.
 - 2) Test Area:
 - a) The Testing and Inspection Agency will test an area not less than 75 feet (23m) by 1 story of structural sealant glazed curtain wall.
 - b. Acceptance Criteria:
 - 1) Structural sealant glazed assemblies that do not evidence water penetration pass the Water Spray Test.
- C. Non-Conforming Work
- 1. The structural sealant glazed curtain walls will be considered defective if they do not pass the specified tests and inspections.

3.05 CLEANING

- A. Perform final cleaning prior to turning the Work of this Section over to the Owner.
- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Protect the structural sealant glazed curtain walls and other items being supplied under this Section from damage by other trades whose Work follows installation of the structural sealant glazed curtain walls.



3.07 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the structural-sealant-glazed curtain walls for inclusion in maintenance manuals as specified in Section 01780, Closeout Submittals.
 - a. Include the recommendations for a post-installation-phase quality control program specified in ASTM C 1401.
2. Submit the operation and maintenance data for the structural-sealant-glazed curtain walls to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	09/07/2018	N/A	All	First edition.





END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02A, 1.02.C.15, 1.03.B2, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System



Phoenix Sky Harbor International Airport
PHX SKY TRAIN Stage 2
PROJECT AV10000011

PACKAGE B04

SPECIFICATIONS

**VOLUME 1 OF 2
PART TWO – DIVISIONS 09 THRU 16**

ISSUED FOR CONSTRUCTION

July 13, 2018



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RFI 1204 24th St and RGC Station Finishes Clarification

RFI 0313 Specifications Required for Station Finishes

Updated



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15122	Expansion Fittings and Loops	12/01/2017
15128	Meters and Gages	12/01/2017
15131	Plumbing Pumps	10/13/2017
15140	Domestic Water Piping	10/06/2017



Section Number	Section Title Package	Date
15145	Domestic Water Piping Specialties	10/06/2017
15150	Sanitary Waste and Vent Piping	10/06/2017
15155	Sanitary Waste Piping Specialties	10/06/2017
15160	Storm Drainage Piping	04/05/2018
15165	Storm Drainage Piping Specialties	10/06/2017
15182	Hydronic Piping	10/06/2017
15186	Refrigerant Piping	10/06/2017
15187	Heating and Cooling Pumps	04/05/2018
15188	HVAC Water Treatment	
15410	Plumbing Fixtures	10/06/2017
15425	Drinking Fountains and Water Coolers	10/06/2017
15485	Electric Domestic Water Heaters	10/06/2017
15623	Centrifugal Water Chillers	04/06/2018
15640	Cooling Towers	04/06/2018
15725	Modular Indoor Central Station Air Handling Units	12/01/2018
15731	Split System Air Conditioning Units	04/05/2018
15763	Fan Coil Units	10/06/2017
15815	Metal Ducts	10/06/2017
15820	Duct Accessories	10/06/2017
15835	Power Ventilators	10/06/2017
15855	Diffusers, Registers, and Grilles	10/06/2017
15861	Air Filters	10/06/2017
15900	HVAC Instrumentation and Controls	10/06/2017
15950	Testing, Adjusting, and Balancing	10/06/2017
15995	Commissioning of Mechanical Systems	10/06/2017
Division 16 - Electrical		
16050	Basic Electrical Materials and Methods	10/06/2017

REL
0629

24th St. and RCC
Stations Hydronic
Piping



Section Number	Section Title Package	Date
16055	Overcurrent Protective Device Coordination	10/06/2017
16061	Electrical Grounding and Bonding	10/06/2017
16070	Hangers and Supports	10/06/2017
16075	Electrical Identification	10/06/2017
16076	Communications Identification	10/06/2017
16080	Electrical Testing	10/06/2017
16081	Communications Testing	10/06/2017
16120	Conductors and Cables	10/06/2017
16121	Medium-Voltage Wire, Cables	10/06/2017
16123	Control-Voltage Power Cables	10/06/2017
16130	Raceway and Boxes	10/06/2017
16134	Cable Trays	10/06/2017
16140	Wiring Devices	10/06/2017
16145	Lighting Control Devices	04/06/2018
16234	Diesel Electric Generators	10/06/2017
16264	Static Uninterruptible Power Supplies	10/06/2017
16289	Transient Voltage Suppression	10/06/2017
16410	Enclosed Switches & Circuit Breakers	10/06/2017
16420	Enclosed Controllers	10/06/2017
16424	Low-Voltage Motor Control Centers	10/06/2017
16441	Switchboards	10/06/2017
16442	Panelboards	10/06/2017
16460	Low-Voltage Transformers	10/06/2017
16491	Fuses	10/06/2017
16497	Automatic Transfer Switches	10/06/2017
16511	Interior Lighting	10/06/2017
16521	Exterior Lighting	12/20/2017



Section Number	Section Title Package	Date
16527	Landscape Lighting	12/01/2017
16702	Basic Communications Materials and Methods	10/06/2017
16705	Pathways for Communication Services	04/06/2018
16711	Communications Equipment Room Fittings	10/06/2017
16712	Communications Backbone Cabling	10/13/2017
16714	Communications Connection Cords, Devices and Adaptors	10/06/2017
16735	Passenger Emergency Duress System (PEDS)	04/06/2018
16995	Commissioning of Electrical Systems	12/20/2017

END OF SECTION





SECTION 09253

GYPSUM SHEATHING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for gypsum sheathing, sheathing joint-and-penetration treatment, and flexible flashing at openings in the sheathing.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 07275 – Fluid-Applied Membrane Air Barriers

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - c. ASTM C 834 - Standard Specification for Latex Sealants.
 - d. ASTM C 954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - e. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - f. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.



- g. ASTM D 3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - h. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - i. ASTM F 1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. Gypsum Association (GA):
 - a. GA-253 – Application of Gypsum Sheathing.
 - b. GA-600 – Fire Resistance Design Manual.
- 4. ICC Evaluation Service, Inc. (ICC-ES):
 - a. ICC-ES Reports™ (ESRs), www.icc-es.org/Evaluation_Reports/index.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 6. National Evaluation Service, Inc. (NES)
 - a. National Evaluation Report (NER):
 - 1) NES NER 272 – Power-Driven Staples and Nails for Use in All Types of Building Construction, https://www.bayarearetrofit.com/PDFs/NER_272.pdf
- 7. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Coordinate the sheathing installation with the installation of materials installed over the sheathing so the sheathing is not exposed to precipitation or left exposed at the end of the workday when rain is forecast.
 - 2. Coordinate the wall sheathing installation with the flashing and joint-sealant installation so these materials are installed in a sequence and manner that prevent exterior moisture from passing through the completed assembly.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:



- 1) Glass-mat gypsum exterior sheathing.
- 2) Fasteners.
- 3) Sealant for glass-mat gypsum sheathing board.
- 4) Sheathing tape for glass-mat gypsum sheathing board.
- 5) Flexible flashing.
- 6) Primer for flexible flashing.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Fire-resistance rating test or evaluation reports from a qualified testing agency or evaluation service.
 - b. Manufacturer's Instructions:
 - 1) Gypsum sheathing manufacturer's written installation instructions.
 - 2) Flexible flashing manufacturer's written installation instructions.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Testing and Inspection Agency:
 - a. To perform approval testing and inspections, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:



1. Deliver materials in their original packages, containers, or bundles bearing the brand name and identification of the manufacturer or supplier.
- B. Storage and Handling Requirements:
 1. Stack panels flat, with spacers between each bundle to provide air circulation.
 - a. Furnish air circulation around the stacks and under coverings.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 GYPSUM SHEATHING

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 3. Product Options:
 - a. Product Data:
 - 1) For each type of process and factory-fabricated product proposed for the Work of this Contract, obtain Product Data that includes the following.
 - a) Component materials and dimensions.
 - b) Construction and application details.
 - c) For building wrap, data on air-/moisture-infiltration protection based on testing according to the referenced standards.
 - 2) Submit the Product Data to the Program/Project Manager for approval.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 2. ENVISION Requirements:
 - a. Recycled Content



- 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Regional Content
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the
 - 2) distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Performance:
1. Fire-Resistance Ratings:
 - a. Provide gypsum sheathing materials and construction identical to those of identical assemblies tested for fire resistance in accordance with the requirements specified in ASTM E 119 and that had the required fire-resistance ratings as indicated in the Contract Documents.
 - 1) Qualified testing and inspecting agencies acceptable to the Authorities Having Jurisdiction, such as Underwriters Laboratories, Inc. (UL), perform testing and follow-up inspections of gypsum sheathing.
 - a) Underwriters Laboratories, Inc. publishes a Fire Resistance Directory which lists all assemblies, systems, and devices UL has tested, and classifies them under Category Codes (CCN) in the UL Online Certifications Directory.
 - 2) The Gypsum Association (GA) lists design designations for designs having specific fire-resistance ratings in GA-600.
 - b. For gypsum sheathing requiring fire-resistance ratings, provide gypsum sheathing listed by Underwriters Laboratories, Inc. (UL), or another testing and inspecting agency acceptable to the Authorities Having Jurisdiction, for the application; or that has an evaluation report from ICC-ES or another evaluation service acceptable to the Authorities Having Jurisdiction showing the sheathing complies with fire rating requirements of the codes applicable to this Contract, or that has an acceptable design designation from GA-600.
 - 1) Submit product test or evaluation reports from a qualified testing agency or evaluation service that indicate the gypsum sheathing complies with the specified requirements based on comprehensive testing of current products to the Program/Project Manager for information.
 2. Mold and Mildew Resistance:



- a. Provide gypsum sheathing materials having properties identical to those of materials having a mold and mildew resistance rating of 10 when tested in accordance with the method specified in ASTM D 3273.
- D. Design Criteria:
 - 1. Fasteners:
 - a. Provide fasteners of the size and type indicated in the Contract Documents, and that comply with the requirements specified in this Section for the material and manufacture.
 - 1) Provide screws having the length recommended by the sheathing manufacturer for the thickness of the sheathing board to be attached.
 - 2) For roof and wall sheathing, provide fasteners having a hot-dip zinc coating complying with the requirements specified in ASTM A 153/A 153M.
- E. Materials:
 - 1. Exterior Sheathing:
 - a. Glass-Mat Gypsum Wall Sheathing:
 - 1) For vertical installations, provide 5/8-inch thick glass-mat gypsum wall sheathing complying with the requirements for Type X sheathing specified in ASTM C 1177/C 1177M, and in 48-inch wide by 120-inch long panels.
 - 2) Manufacturers:
 - a) Georgia-Pacific Gypsum LLC, DensGlass™ Exterior Sheathing, www.buildgyp.com.
 - b) CertainTeed Corporation, GlasRoc®, https://www.certainteed.com/resources/CTG-2355_GlasRoc_Sheathing_Brochure_Eng.pdf
 - c) Approved equal.
 - 2. Fasteners:
 - a. Nails, Brads, and Staples:
 - 1) Provide nails, brads, and staples complying with the requirements specified in ASTM F 1667.
 - b. Power-Driven Fasteners:
 - 1) Provide power-driven fasteners complying with the requirements specified in NES NER 272.
 - c. Screws:
 - 1) Provide steel drill screws having an organic-polymer or other corrosion-protective coating with a salt-spray resistance of more than 800 hours when measured in accordance with the requirements specified in ASTM B 117.
 - 3. Sheathing Joint-and-Penetration Treatment Materials:
 - a. Sealant for Glass-Mat Gypsum Sheathing Board:



- 1) Provide silicone emulsion sealant complying with the requirements specified in ASTM C 834, compatible with the sheathing tape and sheathing, and recommended by the tape and sheathing manufacturers for use with the glass-fiber sheathing tape and for covering exposed fasteners.
- b. Sheathing Tape for Glass-Mat Gypsum Sheathing Board:
 - 1) Provide self-adhering glass-fiber tape of a type recommended by the sheathing and tape manufacturers for use with silicone emulsion sealant for sealing joints in glass-mat gypsum sheathing board, and having a history of successful in-service use.
 - 2) Provide sheathing tape that is a minimum of 2 inches wide, and that has either 10 by 10 or 10 by 20 threads per inch.
4. Miscellaneous Materials:
 - a. Flexible Flashing:
 - 1) Provide composite, self-adhesive, flashing consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - 2) Provide flexible flashing manufactured by the same firm that manufactures the fluid-applied membrane air barriers provided under Section 07275, Fluid-Applied Membrane Air Barriers.
 - 3) Manufacturers:
 - a) Carlisle Coatings and Waterproofing, CCW-705-TWF Thru-Wall Flashing, www.dpproducts.com/products/carlisle/ccw-705-twff.pdf.
 - b) Grace Construction Products, a unit of W. R. Grace and Company, Perm-A-Barrier Detail Membrane Flashing, www.graceathome.com/pages/flashingprod.
 - c) MFM Building Products Corp., Window Wrap, www.mfmbp.com/wintapes.
 - d) Approved equal.
 - b. Primer for Flexible Flashing:
 - 1) Provide primer for the flexible flashing as recommended by the manufacturer of the flexible flashing for the substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the installer present, examine areas and substrates to receive gypsum board assemblies for compliance with requirements and other conditions affecting performance, including welded hollow-metal frames, cast-in anchors, and structural framing.
- B. Evaluation and Assessment:



1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. To prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish, cover them with masking agents, polyethylene film, or other means.
 - a. If despite these precautions, the texture finishes contact the protected surfaces, immediately remove the droppings and overspray according to texture finish manufacturer's written recommendations to prevent damage.

B. Surface Preparation:

1. Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes.
 - a. Ensure that the surfaces are clean, dry, and smooth when the primer is applied.

3.03 INSTALLATION

A. Gypsum Sheathing:

1. Install gypsum sheathing in accordance with the requirements specified in GA-253 and with the manufacturer's installation instructions.
 - a. Where non-load-bearing construction abuts structural elements, install the gypsum sheathing boards to have a 3/8-inch gap between the boards and the structural elements.
 - b. Where non-load-bearing construction abuts masonry or similar materials that might retain moisture, install the gypsum sheathing boards to have a 1/4-inch gap between the boards and the masonry or similar materials to prevent wicking.
 - c. Submit the gypsum sheathing manufacturer's written installation instructions to the Program/Project Manager for information.
2. Do not use materials with defects that impair the quality of the sheathing, or pieces that are too small to use with the minimum number of joints or optimum joint arrangement.
3. Cut gypsum sheathing panels at penetrations, edges, and other obstructions to the work.
 - a. Fit gypsum sheathing panels tightly against abutting construction, unless otherwise indicated herein.
4. Do not bridge building expansion joints.
 - a. Cut and space the edges of gypsum sheathing panels to match the spacing of the structural support elements.
5. Securely attach the gypsum sheathing to the substrate by fastening as indicated herein.



- a. Use common wire nails, unless otherwise indicated in the Contract Documents or referenced schedule.
 - 1) Where the opposite side will be exposed to view or will receive finish materials, select fasteners of a size that will not fully penetrate the members.
 - 2) Install fasteners without splitting the wood.
 - 3) Install fasteners in accordance with requirements indicated in "Table 2304.9.1 Fastening Schedule" in the ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 4) For power-driven fasteners, comply with the requirements specified in NES NER 272.
- b. Make tight connections.
 - 1) Apply fasteners so their heads bear tightly against the face of the sheathing boards, but do not cut into the sheathing board facing.
- c. Fasten gypsum sheathing to cold-formed metal framing using screws.
 - 1) For steel framing less than 0.0329 inch thick, attach sheathing in accordance with the requirements specified in ASTM C 1002.
 - 2) For steel framing from 0.033 to 0.112 inch thick, attach sheathing in accordance with the requirements specified in ASTM C 954.
- 6. Vertical Installation:
 - a. Install gypsum board sheathing so its vertical edges are centered over the studs.
 - 1) Abut the ends and edges of each gypsum board sheathing panel with those of adjacent boards.
 - b. Attach boards at their perimeter and within the field of the board to each stud.
 - 1) Space fasteners approximately 8 inches apart on center, and set back a minimum of 3/8 inch from the edges and ends of boards.
 - 2) For sheathing under stucco cladding, the boards may be initially tacked in place with screws if the overlying self-furring metal lath is screw-attached through the sheathing to studs immediately after the sheathing is installed.
- B. Sheathing Joint-and-Penetration Treatment:
 - 1. Seal the gypsum sheathing joints in accordance with the gypsum sheathing manufacturer's installation instructions.
 - a. Apply elastomeric sealant to the joints and fasteners, and trowel the sealant flat.
 - 1) Apply a sufficient quantity of sealant to completely cover the joints and fasteners after troweling.
 - 2) Seal other penetrations and openings.
 - b. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed the entire face of tape in sealant.
 - 1) Apply sealant to exposed fasteners with a trowel so the fasteners are completely covered.



- 2) Seal other penetrations and openings.
 - c. Submit the gypsum sheathing manufacturer's written installation instructions to the Program/Project Manager for information.
- C. Flexible Flashing:
- 1. Apply flexible flashing where indicated in the Contract Documents and in accordance with the flexible flashing manufacturer's instructions.
 - a. Prime substrates as recommended by the flexible flashing manufacturer.
 - b. Lap the seams and junctures with other materials at least 4 inches, except the laps at the flashing flanges of other construction do not need to exceed the flange width.
 - c. At the bottom and sides of openings, lap the flexible flashing over weather-resistant building paper.
 - d. At the heads of openings, lap weather-resistant building paper over the flexible flashing.
 - e. After the flexible flashing has been applied, roll the surfaces with a hard rubber or metal roller to ensure that the flexible flashing is completely adhered to the substrates.
 - f. Submit the flexible flashing manufacturer's written installation instructions to the Program/Project Manager for information.

3.04 CLEANING

- A. Waste Management:
- 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Take steps to insure that installed gypsum sheathing is protected during subsequent construction activities.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing gypsum board assemblies as indicated on the Contract Drawings and herein:
 - a. Framing installation.
 - b. Gypsum board panel application.
 - c. Trim installation.
 - d. Finishing of gypsum board assemblies, including texture finishes.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 07210 - Building Insulation.
 - 3. Section 07275 – Fluid Applied Membrane Air Barriers.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. SCAQMA: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Standard definitions of terms for gypsum board assemblies that apply to the Work of this Section and not defined in this Section or in other referenced standards are defined in ASTM C 11.
 - 2. Cripple Studs: Short studs placed between the header/lintel and a top plate, or between a sill and bottom plate. A stud used above or below a



wall opening, and extending from the header to the top plate or from the sole plate to the rough sill.

C. Reference Standards:

1. American National Standards Association (ANSI):
 - a. ANSI A108.11 - Specifications for Interior Installations of Cementitious Backer Units.
 - b. ANSI A118.9 – Specifications for Cementitious Backer Units (included in AANSI A108.1)
2. ASTM International (ASTM):
 - a. ASTM A 641/A 641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - d. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
 - e. ASTM C 11 – Standard Terminology Relating to Gypsum and Related Building Materials and Systems.
 - f. ASTM C 475/C 475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - g. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members.
 - h. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - i. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - j. ASTM C 840 - Standard Specification for Application and Finishing of Gypsum Board.
 - k. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - l. ASTM C 1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - m. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.
 - n. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - o. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - p. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. City of Phoenix (COP):



- a. Phoenix Building Construction Code and Amendments.
- 4. Gypsum Association (GA):
 - a. GA-216 – Application and Finishing of Gypsum Panel Products.
 - b. GA-600 – Fire Resistance Design Manual.
- 5. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 6. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 7. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.
- 8. United States Gypsum:
 - a. Gypsum Construction Handbook,
<https://www.usg.com/content/usgcom/en/resource-center/gypsum-construction-handbook.html>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Suspended Ceilings:
 - a. Coordinate the installation of ceiling suspension systems with the installation of the overhead structure to ensure that inserts and other provisions for anchorage to the building structure have been properly installed to receive the ceiling hangers at the spacing required to support the ceilings, and that hangers will develop their full strength.
- B. Sequencing:
 - 1. Install sound attenuation blankets before installing gypsum panels, unless the blankets can be readily installed after the gypsum panels have been installed on one side of a partition.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Steel suspended ceiling and soffit framing components.
 - 2) Steel partition and soffit framing components.
 - 3) Interior gypsum wallboard.
 - 4) Exterior gypsum panels for ceilings and soffits.
 - 5) Tile backing panels.
 - 6) Trim accessories.
 - 7) Joint treatment materials.



- 8) Laminating adhesive.
- 9) Steel drill screws.
- 10) Isolation strip at exterior walls.
- 11) Sound attenuation blankets.
- 12) Polystyrene aggregate ceiling finish.
- b. Samples:
 - 1) Textured Finishes Samples.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA1.3 – Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.

1.05 QUALITY ASSURANCE

A. Site Samples:

- 1. Textured Finishes Samples:
 - a. Submit 24-inch by 24-inch Samples of textured finishes.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Deliver materials in their original packages, containers, or bundles bearing the brand name and identification of the manufacturer or supplier.

B. Storage and Handling Requirements:

- 1. Store materials inside under cover, and keep them dry and protected against damage from the weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.



2. Stack gypsum panels flat on leveled supports off the ground and a protective covering to prevent sagging.
3. Handle gypsum boards so damage to edges, ends, and surfaces is prevented.
4. Protect metal corner beads and trim from being bent or otherwise damaged.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Ventilation:
 - a. Ventilate building spaces as required to remove water in excess of that required for drying joint treatment material immediately after its application.
 - b. Avoid drafts during dry, hot weather to prevent too rapid drying.
2. Cold Weather Protection:
 - a. When ambient outdoor temperatures are below 55 degrees Fahrenheit, maintain continuous, uniform comfortable building working temperatures not less than 55 degrees Fahrenheit and not more than 70 degrees Fahrenheit for a minimum of 48 hours prior to, during, and following installation of gypsum board and joint treatment materials or bonding of adhesives.

B. Existing Conditions:

1. Comply with the installation requirements for the conditions existing at the Site as specified in ASTM C 840, or with the gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Manufacturers:

1. Manufacturer Lists:
 - a. Steel Framing and Furring Manufacturers:
 - 1) Dietrich Industries, Inc., www.dietrichmetalf framing.com.
 - 2) National Gypsum Company, www.nationalgypsum.com.
 - 3) Allied Studco, Inc., www.studco.com.
 - 4) California Expanded Metal Products Co., www.cemcosteel.com.
 - 5) ClarkWestern Building Systems, www.clarkwestern.com.
 - 6) Approved equal.
 - b. Gypsum Board and Related Products Manufacturers:
 - 1) American Gypsum Co., www.americangypsum.com.
 - 2) Georgia-Pacific Gypsum Corporation, <https://www.gp.com>.
 - 3) National Gypsum Company, www.nationalgypsum.com.
 - 4) United States Gypsum Company, www.usg.com.



- 5) Approved equal.
- c. Accessory Manufacturers:
 - 1) Fry Reglet Corp., www.fryreglet.com.
 - 2) National Gypsum Company, www.nationalgypsum.com.
 - 3) California Expanded Metal Products Co., www.cemcosteel.com.
 - 4) ClarkWestern Building Systems, www.clarkwestern.com.
 - 5) Approved equal.
- d. Texture Finish Manufacturers:
 - 1) Georgia-Pacific Gypsum Corporation; GyProc Ceiling Texture/Polystyrene, www.gp.com.
 - 2) National Gypsum Company; Gold Bond Perfect Spray, www.nationalgypsum.com.
 - 3) United States Gypsum Company, SHEETROCK Ceiling Spray Texture, QT Polystyrene, www.usg.com.
- e. Grid Suspension System for Interior Ceilings Manufacturers:
 - 1) Armstrong World Industries, Inc., Furring Systems/Drywall, www.armstrong.com.
 - 2) Chicago Metallic Corporation, www.chicagometallic.com.
 - 3) USG Interiors, Inc., Drywall Suspension System, www.usg.com.
- f. Tile Backing Manufacturers:
 - 1) Custom Building Products; Wonderboard, www.custombuildingproducts.com.
 - 2) United States Gypsum Co.; DUROCK Cement Board, www.usg.com.
- g. Aluminum Trim Manufacturers
 - 1) Fry Reglet Corporation, www.fryreglet.com.
 - 2) MM Systems Corporation, www.mmsystemscorp.com.
- h. Cementitious Backer Unit Manufacturers:
 - 1) Custom Building Products; Wonderboard, www.custombuildingproducts.com.
 - 2) United States Gypsum Co.; DUROCK Cement Board, www.usg.com.
- 2. Substitution Limitations:
 - a. The products specified establish standards for kind, quality, and function desired for this Contract.
 - b. The use of a manufacturer's proprietary product name to designate materials is not intended to imply that the products named are required to be used to the exclusion of equivalent products of other manufacturers.
 - c. Submit the manufacturer's material data and certificates of performance for proposed substitutions.
- 3. Product Options:
 - a. Submit the manufacturer's Product Data for each type of product indicated and provided.



B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).

2. ENVISION Requirements:

a. Recycled Content

- 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

b. Regional Content

- 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

3. Sustainable Requirements

a. Volatile Organic Compounds (VOC) Content of Interior Sealants:

- 1) Provide sealants and sealant primers for the gypsum board assemblies of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:

- a) Drywall and panel adhesives: 50 grams per Liter less water.

C. Performance:

1. Fire-Test-Response Characteristics:

- a. For gypsum board assemblies required to have fire-resistance ratings, provide materials and construction identical to those of assemblies that have had their fire-resistance ratings determined by testing performed by an independent testing and inspecting agency acceptable to the Authorities Having Jurisdiction in accordance with the methods specified in ASTM E 119.

D. Materials:

1. Steel Suspended Ceiling and Soffit Framing:

- a. Provide components for the steel suspended ceiling and soffit framing system complying with the requirements specified in ASTM C 754 for the conditions indicated on the Contract Drawings.
- b. Tie Wire:



- 1) Provide tie wire complying with the requirements specified in ASTM A 641/A 641M, for soft temper, 0.0625-inch diameter wire, or a double strand of 0.0475-inch diameter wire, with a Class 1 zinc coating.
- c. Hangers:
 - 1) Provide hangers complying with the following requirements:
 - a) Wire Hangers:
 - (1) Provide soft temper, 0.162-inch diameter wire hangers with a Class 1 zinc coating complying with the requirements specified in ASTM A 641/A 641M.
 - b) Angle Hangers:
 - (1) Provide angle hangers complying with the requirements for hot-dip galvanized commercial-steel (CS) sheet with a G60 (Z180) Coating Designation as specified in ASTM A 653/A 653M.
 - (a) Minimum Base Metal Thickness: 0.0179 inch (0.45 mm).
 - (b) Size: 7/8 inch by 1-3/8 inches (22.2mm by 34.9mm) or 1-5/8 inches by 1-5/8 inches (41.3mm by 41.3mm).
- d. Carrying Channels:
 - 1) Provide carrying channels fabricated from 0.0538 inch (1.37mm) thick cold-rolled, hot-dip galvanized steel base metal and at least a 1/2-inch (12.7mm) wide flange complying with the requirements for commercial-steel (CS) sheet with a G60 (Z180) Coating Designation as specified in ASTM A 653/A 653M.
 - a) Depth: 2 inches.
- e. Furring Channels (Furring Members):
 - 1) Provide furring channels (furring members) fabricated from hot-dip galvanized steel complying with the requirements for commercial-steel (CS) sheet with a G60 (Z180) Coating Designation as specified in ASTM A 653/A 653M
 - a) Steel Studs:
 - (1) Provide steel studs fabricated from steel complying with the requirements specified in ASTM C 645.
 - (2) Depth: As indicated on the Contract Drawings.
- f. Grid Suspension System for Interior Ceilings:
 - 1) Provide a direct-hung grid suspension system for interior ceilings composed of interlocking main beams and cross-furring members complying with the requirements specified in ASTM C 645.
2. Steel Partition and Soffit Framing:
 - a. Provide components for the steel partition and soffit framing system complying with the requirements specified in ASTM C 754 for the conditions indicated on the Contract Drawings.
 - 1) Steel Sheet Components:



- a) Provide steel sheet components complying with the requirements of ASTM C 754 metal, and galvanized with a G60 (Z180) Coating Designation as specified in ASTM A 653/A 653M.
- b. Steel Studs and Runners:
 - 1) Provide steel studs and runners complying with the requirements of ASTM C 754.
 - 2) Minimum Base Metal Thickness: 0.027 inch (0.7mm).
 - 3) Depth: As indicated on the Contract Drawings.
- c. Deep-Leg Deflection Track:
 - 1) Provide deep-leg deflection track consisting of a top runner with 2-inch (50.8mm) deep flanges complying with the requirements of ASTM C 645.
- d. Flat Strap and Backing Plate:
 - 1) Provide a flat strap and backing plate consisting of steel sheet blocking and bracing.
 - 2) Length and Width: As indicated on the Contract Drawings.
 - 3) Minimum Base Metal Thickness: 0.027 inch (0.7mm).
- e. Cold-Rolled Channel Bridging:
 - 1) Provide cold-rolled channel bridging fabricated from 0.0538 inch (1.37mm) thick bare steel, with at least a 1/2 inch (12.7mm) wide flange.
 - a) Depth: 1-1/2 inches (38.1mm).
 - 2) Clip Angle:
 - a) Provide 1-1/2 inch by 1-1/2 inch (38.1mm by 38.1mm), 0.068-inch- (1.73mm) thick, galvanized steel clip angles.
- f. Hat-Shaped, Rigid Furring Channels:
 - 1) Provide hat-shaped, rigid furring channels complying with the requirements of ASTM C 645.
 - 2) Minimum Base Metal Thickness: 0.0179 inch (0.45mm).
 - 3) Depth: 1-1/2 inches (38.1mm).
- g. Resilient Furring Channels:
 - 1) Provide asymmetrical or hat shaped resilient furring channels, designed to reduce sound transmission, and consisting of 1/2-inch (12.7mm) deep steel sheet members with their faces attached to a single flange by a slotted leg (web), or attached to 2 flanges by slotted or expanded metal legs.
- h. Cold-Rolled Furring Channels:
 - 1) Provide cold-rolled furring channels fabricated from 0.0538 inch (1.37mm) thick bare steel, with at least a 1/2 inch (12.7mm) wide flange.
 - a) Depth: 3/4 inch (19.1mm).
 - 2) Furring Brackets:



- a) Provide furring brackets fabricated from adjustable, corrugated-edge steel sheet having a bare steel thickness of at least 0.0312 inch (0.79mm) thick.
 - 3) Tie Wire:
 - a) Provide tie wire complying with the requirements specified in ASTM A 641/A 641M, for soft temper, 0.0625-inch diameter wire, or a double strand of 0.0475-inch diameter wire, with a Class 1 zinc coating.
 - i. Z-Shaped Furring:
 - 1) Provide Z-shaped furring having slotted or non-slotted webs, 1-1/4-inch (31.8mm) face flanges, 7/8-inch (22.2mm) wall attachment flanges, at least 0.0179 inch (0.45mm) thick bare metal, and depths as required to accommodate the insulation thickness indicated on the Contract Drawings.
 - j. Fasteners for Metal Framing:
 - 1) Provide fasteners for metal framing of the type, material, size, corrosion resistance, holding power, and other properties required to fasten the steel members to the substrates.
- 3. Interior Gypsum Wallboard:
 - a. Panel Size:
 - 1) Provide interior gypsum wallboard of the maximum lengths and widths available that will minimize joints in each area, and correspond with the support system indicated on the Contract Drawings.
 - b. Gypsum Wallboard:
 - 1) Provide Type X gypsum wallboard complying with the requirements specified in ASTM C 1396/C 1396M.
 - a) Thickness: 5/8 inch (15.9mm), unless noted otherwise.
 - b) Long Edges: Tapered.
 - c. Abuse-Resistant Gypsum Wallboard:
 - 1) Provide Type X gypsum wallboard complying with the requirements specified in ASTM C 1396/C 1396M, and manufactured to produce greater resistance to surface indentation and through-penetration than standard gypsum panels.
 - a) Core: 5/8 inch (15.9mm), unless noted otherwise.
 - b) Long Edges: Tapered.
- 4. Exterior Gypsum Panels for Ceilings and Soffits:
 - a. Panel Size:
 - 1) Provide exterior gypsum panels for ceilings and soffits of the maximum lengths and widths available that will minimize joints in each area, and correspond with the support system indicated on the Contract Drawings.
 - b. Exterior Gypsum Soffit Board:
 - 1) Provide Type X exterior gypsum panels for ceilings and soffits complying with the requirements specified in



- ASTM C 1396/C 1396M, and having the manufacturer's standard edges.
- a) Core: 5/8 inch (15.9mm).
5. Tile Backing Panels:
- a. Panel Size:
 - 1) Provide tile backing panels of the maximum lengths and widths available that will minimize joints in each area, and correspond with the support system indicated on the Contract Drawings.
 - b. Water-Resistant Gypsum Backing Board:
 - 1) Provide Type X water-resistant gypsum backing board complying with the requirements specified in ASTM C 1396/C 1396M.
 - a) Core: 5/8 inch (15.9mm), unless noted otherwise.
 - c. Cementitious Backer Units:
 - 1) Provide cementitious backer units complying with the requirements specified in ANSI A118.9.
 - 2) Thickness: 5/8 inch (15.9mm).
6. Trim Accessories:
- a. Interior Trim:
 - 1) Provide interior trim complying with the requirements specified in ASTM C 1047.
 - 2) Material:
 - a) Provide interior trim fabricated from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
 - 3) Shapes:
 - a) Cornerbead:
 - b) Bullnose Bead:
 - c) LC-Bead:
 - (1) Provide J-shaped LC-bead.
 - d) L-Bead:
 - (1) Provide L-shaped L-bead.
 - e) U-Bead:
 - (1) Provide J-shaped U-bead.
 - f) Expansion (Control) Joint:
 - g) Curved-Edge Cornerbead:
 - (1) Provide curved-edge cornerbeads having notched or flexible flanges.
 - b. Exterior Trim:
 - 1) Provide exterior trim complying with the requirements specified in ASTM C 1047.
 - 2) Material:
 - a) Provide interior trim fabricated from hot-dip galvanized steel sheet or rolled zinc.
 - 3) Shapes:
 - a) Cornerbead:



- b) LC-Bead:
 - (1) Provide J-shaped LC-bead.
 - c) Expansion (Control) Joint:
 - (1) Provide one-piece, rolled zinc expansion (control) joints with a V-shaped slot and a removable strip for covering the slot opening.
 - c. Aluminum Trim:
 - 1) Provide extruded aluminum accessories having profiles and dimensions as indicated on the Contract Drawings.
 - 2) Aluminum:
 - a) Provide 6063-T5 aluminum with strength and durability properties not less than as specified in ASTM B 221 or ASTM B 221M.
 - 3) Finish:
 - a) Provide a corrosion-resistant primer compatible with the joint compound and finish materials specified.
- 7. Joint Treatment Materials:
 - a. Provide joint treatment materials complying with the requirements specified in ASTM C 475.
 - b. Joint Tape:
 - 1) Interior Gypsum Wallboard: Paper.
 - 2) Exterior Gypsum Soffit Board: Paper.
 - 3) Tile Backing Panels: As recommended by the panel manufacturer.
 - c. Joint Compound for Interior Gypsum Wallboard:
 - 1) For each coat, use a formulation that is compatible with other compounds applied on previous or for successive coats.
 - 2) Prefilling:
 - a) At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 3) Embedding and First Coat:
 - a) For the embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
 - b) Use setting-type compound for installing paper-faced metal trim accessories.
 - 4) Fill Coat:
 - a) For the second coat, use either setting-type, sandable topping compound or drying-type, all-purpose compound.
 - 5) Finish Coat:
 - a) For the third coat, use either setting-type, sandable topping compound or drying-type, all-purpose compound.
 - 6) Skim Coat:



- a) For the final coat of a Level 5 finish, use either setting-type, sandable topping compound or drying-type, all-purpose compound.
- d. Joint Compound for Exterior Applications:
 - 1) Exterior Gypsum Soffit Board:
 - a) Use setting-type taping and setting-type, sandable topping compounds.
 - e. Joint Compound for Tile Backing Panels:
 - 1) Water-Resistant Gypsum Backing Board:
 - a) Use setting-type taping and setting-type, sandable topping compounds.
 - 2) Cementitious Backer Units:
 - a) Use joint compound as recommended by the cementitious backer unit manufacturer.

2.02 ACCESSORIES

- A. Laminating Adhesive:
 - 1. Provide adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- B. Steel Drill Screws:
 - 1. Unless otherwise indicated, provide steel drill screws complying with the requirements specified in ASTM C 1002.
 - 2. For fastening panels to steel members from 0.033 to 0.112 inch (0.84mm to 2.84mm) thick, provide screws complying with the requirements specified in ASTM C 954.
 - 3. For fastening cementitious backer units, provide screws of the type and size recommended by the panel manufacturer.
- C. Isolation Strip at Exterior Walls:
 - 1. Asphalt-Saturated Organic Felt:
 - a. Provide Type I (No. 15 asphalt felt), nonperforated asphalt-saturated organic felt complying with the requirements specified in ASTM D 226.
 - 2. Foam Gasket:
 - a. Provide 1/8 inch (3.2mm) thick, adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, in a width to suit the size of the steel stud.
- D. Sound Attenuation Blankets:
 - 1. Provide Type I sound attenuation blankets (blankets without membrane facing) complying with the requirements specified in ASTM C 665, and produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 2. Fire-Resistance-Rated Assemblies:



- a. Provide fire-resistance-rated assemblies complying with the mineral-fiber requirements of the assembly.
- E. Thermal Insulation:
 - 1. Provide thermal insulation as specified in Section 07210, Building Insulation.
- F. Polyethylene Vapor Retarder:
 - 1. Provide polyethylene vapor retarder as specified in Section 07275, Fluid-Applied Membrane Air Barriers.
- G. Texture Finishes:
 - 1. Polystyrene Aggregate Ceiling Finish:
 - a. Provide water-based, job-mixed polystyrene aggregate finish.
 - b. Texture: Fine.
 - c. Flame-Spread Index: No more than 25 when tested according to ASTM E 84.
 - d. Smoke-Developed Index: No more than 25 when tested according to ASTM E 84.
 - e. Primer:
 - 1) Provide a primer for the polystyrene aggregate finish as recommended by textured finish manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine areas and substrates to receive gypsum board assemblies for compliance with requirements and other conditions affecting performance, including welded hollow-metal frames, cast-in anchors, and structural framing.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. To prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish, cover them with masking agents, polyethylene film, or other means.
 - a. If despite these precautions, the texture finishes contact the protected surfaces, immediately remove the droppings and overspray according



to texture finish manufacturer's written recommendations to prevent damage.

B. Surface Preparation:

1. Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes.
 - a. Ensure that the surfaces are clean, dry, and smooth when the primer is applied.

3.03 FRAMING INSTALLATION

A. Installing Steel Framing:

1. Installation Standards:
 - a. Comply with the requirements that apply to framing installation as specified in ASTM C 754 and ASTM C 840.
2. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
 - a. Comply with the details indicated on the Contract Drawings, and with the gypsum board manufacturer's written recommendations, or if none are available, then with United States Gypsum's *The Gypsum Construction Handbook*.
3. Isolate steel framing from the building structure at the locations indicated on the Contract Drawings to prevent transfer of loading imposed by structural movement.
 - a. Isolate ceiling assemblies where they abut or are penetrated by the building structure.
 - b. Isolate partition framing and wall furring where it abuts the structure, except at the floor.
 - 1) Install slip-type joints at the head of assemblies that avoid axial loading of the assembly, and laterally support assembly.
 - 2) Use deep-leg deflection track where indicated on the Contract Drawings.
4. Do not bridge building control and expansion joints with steel framing or furring members.
 - a. Frame both sides of joints independently.

B. Installing Steel Suspended Ceiling and Soffit Framing:

1. Suspend ceiling hangers from the building structure as follows:
 - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.
 - 1) Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or using other equally effective means.



- b. Where the width of ducts and other construction within the ceiling plenum produces hanger spacings that interfere with the location of the hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - 1) Size the supplemental suspension members and hangers to support the ceiling loads within performance limits established by the referenced standards.
- c. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for the substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
- d. Secure flat or angle hangers to the structure, including intermediate framing members, by attaching the hangers to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for the structure and hanger, and in a manner that will not cause the hangers to deteriorate or otherwise fail.
- e. Do not attach hangers to steel roof deck.
- f. Attach hangers to structural members.
- g. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- 2. Sway-brace suspended steel framing with the hangers or studs used for support.
- 3. For exterior soffits, install cross bracing and framing to resist wind uplift.
- 4. Wire-tie furring channels to supports, as required to comply with the requirements for the assemblies indicated on the Contract Drawings.
- 5. Install suspended steel framing components of the sizes and at the spacing as specified herein or indicated on the Contract Drawings, but not less than that required by the referenced steel framing and installation standards.
 - a. Hangers: 48 inches on center.
 - b. Carrying Channels (Main Runners): 48 inches on center.
 - c. Furring Channels (Furring Members): As indicated on the Contract Drawings.
- 6. Grid Suspension System:
 - a. Attach perimeter wall track or angle where the grid suspension system meets vertical surfaces.
 - b. Mechanically join the main beam and cross-furring members to each other, and butt-cut them to fit into the wall track.
- C. Installing Steel Partition and Soffit Framing:
 - 1. Where gypsum board assemblies abut other construction, install tracks (runners) at floors, ceilings, and structural walls and columns.
 - a. Where studs are installed directly against exterior walls, install an asphalt-felt or foam-gasket isolation strip between the studs and wall.



2. Except where partitions are indicated to terminate at suspended ceilings, extend partition framing the full height to the structural supports or substrates above suspended ceilings.
 - a. Continue the framing over the frames for doors and openings, and frame around ducts penetrating partitions above the ceiling to provide support for the gypsum board.
 - b. Cut studs 1/2 inch (13mm) short of the full height to provide perimeter relief.
 - c. For fire-resistance-rated partitions extending to the underside of floor/roof slabs and decks, or other continuous solid-structure surfaces, to obtain the required ratings, install the framing around structural and other members extending below the floor/roof slabs and decks, as needed to support the gypsum board closures and to make partitions continuous from the floor to the underside of the solid structure.
 - 1) Terminate partition framing at suspended ceilings where indicated on the Contract Drawings.
3. Space steel studs and furring as follows:
 - a. Single-Layer Construction: 24 inches apart on center, unless otherwise indicated on the Contract Drawings.
 - b. Cementitious Backer Units: 16 inches apart on center, unless otherwise indicated on the Contract Drawings.
4. Install steel studs so their flanges point in the same direction, and the leading edge or end of each panel can be attached to open (unsupported) edges of the stud flanges first.
5. Unless otherwise indicated on the Contract Drawings, frame door openings in accordance with the requirements of GA-600 and with gypsum board manufacturer's applicable written recommendations.
 - a. Screw the vertical studs at jambs to jamb anchor clips on the door frames.
 - b. Install the runner track section for cripple studs at its head, and secure it to jamb studs.
 - c. Unless otherwise indicated, install 2 studs at each jamb.
 - d. Install cripple studs at the head adjacent to each jamb stud, with a minimum clearance of 1/2-inch from the jamb stud to allow for installation of a control joint.
 - e. Extend jamb studs through suspended ceilings, and attach them to the underside of the floor or roof structure above.
6. Unless otherwise indicated on the Contract Drawings, frame openings, other than door openings, the same as required for the door openings.
 - a. Install framing below the sills of openings to match the framing required above door heads.
7. Z-Furring Members:
 - a. Erect insulation vertically and hold it in place with Z-furring members spaced 24 inches apart on center.



- b. Except at exterior corners, securely attach the narrow flanges of furring members to walls with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600mm) on center.
- c. At exterior corners, attach the wide flange of furring members to walls with the short flange extending beyond the corner; on the adjacent wall surface, screw-attach the short flange of the furring channel to the web of the attached channel.
- d. At interior corners, space the second member no more than 12 inches (300mm) from the corner, and cut the insulation to fit.

3.04 PANEL APPLICATION

- A. Gypsum Board Application and Finishing Standards:
 - 1. Comply with the requirements that apply to panel application as specified in ASTM C 840 and GA-216.
- B. Install interior gypsum wallboard at the locations indicated on the Contract Drawings.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints, and to avoid abutting end joints in the central area of each ceiling.
 - 1. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with the face side out.
 - 1. Butt panels together to provide light contact at the edges and ends, with not more than 1/16 inch of open space between panels.
 - 2. Do not force panels into place.
- E. Locate the edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints.
 - 1. Do not place tapered edges against cut edges or ends.
 - 2. Stagger vertical joints on opposite sides of partitions.
 - 3. Other than control joints, do not make joints at the corners of framed openings.
- F. Attach gypsum panels to steel studs so the leading edge or end of each panel is attached to open (unsupported) edges of the stud flanges first.
- G. Attach gypsum panels to the framing provided at openings and cutouts.
- H. Form control and expansion joints with space between the edges of adjoining gypsum panels.



- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings and similar concealed places), except in internally braced chases.
 - 1. Unless a concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps not less in area than 8 square feet.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below the underside of floor/roof slabs and decks, cut the gypsum panels to fit the profile formed by the coffers, joists, and other structural members.
 - a. To install sealant, provide joints 1/4 inch to 3/8 inch wide.
- J. Except at floors, isolate the perimeter of non-load-bearing gypsum board partitions at structural abutments.
 - 1. Provide spaces 1/4 inch to 1/2 inch wide at these locations, and trim the edges with U-bead edge trim where the edges of the gypsum panels are exposed.
 - 2. Seal joints between the edges and abutting structural surfaces with acoustical sealant.
- K. Space the fasteners in gypsum panels according to the referenced gypsum board application and finishing standard and the manufacturer's written recommendations.
- L. Space the fasteners in panels that are tile substrates a maximum of 8 inches apart on center.

3.05 PANEL APPLICATION METHODS

- A. Single-Layer Application:
 - 1. Apply the gypsum panels on ceilings before applying wall/partition board to the greatest extent possible, and at right angles to the framing unless otherwise indicated on the Contract Drawings.
 - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to the framing), unless otherwise indicated or required by a fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to the framing) with no end joints.
 - a. Locate edge joints over furring members.
- B. Single-Layer Fastening Methods:
 - 1. Apply gypsum panels to supports with steel drill screws.



C. Laminating Panels to Substrates:

1. Where gypsum panels are indicated as directly adhered to a substrate other than studs, joists, furring members, or base layer of gypsum board, comply with the gypsum board manufacturer's written recommendations, and temporarily brace or fasten the gypsum panels until the fastening adhesive has set.

D. Exterior Soffits and Ceilings:

1. Apply exterior gypsum soffit board panels perpendicular to supports, with the end joints staggered and located over supports.
2. Install exterior gypsum soffit board panels to allow a 1/4-inch (6.4mm) open space where panels abut other construction or structural penetrations.
3. Fasten exterior gypsum soffit board panels with corrosion-resistant screws.

E. Tile Backing Panels:

1. Water-Resistant Gypsum Backing Board:
 - a. Install water-resistant gypsum backing board at showers, tubs, and where indicated on the Contract Drawings.
 - 1) Provide water-resistant gypsum backing board in ceilings only if indicated in the Room Finish Schedule on the Contract Drawings.
 - b. Install water-resistant gypsum backing board to allow a 1/4-inch gap where the panels abut other construction or penetrations.
2. Cementitious Backer Units:
 - a. Install cementitious backer units in accordance with the requirements specified in ANSI A108.11.
 - b. Provide cementitious backer units in the walls in showers, behind ceramic tile surfaces, and in other locations indicated on the Contract Drawings.

3.06 INSTALLING TRIM ACCESSORIES

A. Attachment Methods:

1. For trim with back flanges designed to accept fasteners, attach the trim to framing with the same fasteners used for attaching the panels.
2. For trim without back flanges, attach the trim according to manufacturer's written instructions.

B. Interior Trim:

1. Unless otherwise indicated, provide cornerbeads at outside corners.
2. Provide bullnose beads at outside corners.
3. Provide LC-beads at exposed panel edges.
 - a. Provide joint compound at the exposed long flanges.
4. Provide L-beads at exposed panel edges.
 - a. Provide joint compound at the exposed long leg.



5. Provide U-beads at exposed panel edges.
 - a. Do not provide joint compound at the exposed short flange.
6. Provide expansion (control) joints where required.
7. Provide curved-edge cornerbeads at curved openings.

C. Exterior Trim:

1. Provide cornerbeads at outside corners.
2. Provide LC-beads at exposed panel edges.
 - a. Provide joint compound at the exposed long flanges.
3. Provide expansion (control) joints where required.

3.07 FINISHING GYPSUM BOARD ASSEMBLIES

A. Surface Preparation:

1. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and other conditions as required to prepare gypsum board surfaces for decoration.
2. Promptly remove residual joint compound from adjacent surfaces.
3. Prefill open joints, rounded or beveled edges, and damaged surface areas.
4. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

B. Gypsum Board Finish Levels:

1. Where finish levels are indicated on the Contract Drawings, finish gypsum board panels to the indicated level(s) as specified in ASTM C 840:
 - a. Level 0:
 - 1) No taping, finishing or accessories are required.
 - b. Level 1:
 - 1) Embed tape in joint compound at joints and interior angles.
 - 2) The surface must be free of excess joint compound.
 - 3) Tool marks and ridges are acceptable.
 - c. Level 2:
 - 1) Embed tape in joint compound, and apply 1 separate coat of joint compound over the joints, angles, fastener heads, and accessories.
 - 2) The surface must be free of excess joint compound.
 - 3) Tool marks and ridges are acceptable.
 - d. Level 3:
 - 1) Embed tape in joint compound, and apply 2 separate coat of joint compound over the joints, angles, fastener heads, and accessories.
 - 2) The joint compound must be smooth and free of tool marks and ridges.
 - e. Level 4:



- 1) Embed tape in joint compound, and apply 3 separate coats of joint compound over all joints, angles, fastener heads, and accessories.
 - 2) The joint compound must be smooth and free of tool marks and ridges.
 - f. Level 5:
 - 1) Embed tape and apply separate first, fill, and finish coats of joint compound to the tape, fasteners, and trim flanges; and apply a skim coat of joint compound, or material manufactured especially for this purpose, over entire surface.
 - 2) The surface must be smooth and free of tool marks and ridges.
 2. Where no finish level is indicated on the Contract Drawings, provide a Level 4 finish.
- C. Cementitious Backer Units:
 1. Finish cementitious backer units according to backer unit manufacturer's written instructions.
- D. Texture Finish Application:
 1. Mix and apply the finish using powered spray equipment to produce a uniform texture free of starved spots or other evidence of thin application or application patterns.

3.08 TOLERANCES:

- A. Steel Framing Components for Suspended Ceilings:
 1. Install steel framing components for suspended ceilings so the members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.
- B. Steel Partition and Soffit Framing:
 1. Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3mm) from the plane formed by the faces of adjacent framing.

3.09 SITE QUALITY CONTROL

- A. Inspections:
 1. Above-Ceiling Observation:
 - a. Before the Contractor installs gypsum board ceilings, the Program/Project Manager, or his designee, will conduct an above-ceiling observation and report deficiencies in the Work observed.
 - 1) Notify the Program/Project Manager 7 days in advance of the date and time when the Contract Work, or part of the Contract Work, will be ready for above-ceiling observation.



B. Non-Conforming Work

1. Do not proceed with installation of gypsum board to the ceiling support framing until deficiencies have been corrected.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All.	First edition.
1	12/20/2017	N/A	1.01.A.1, 1.02.C.7, 1.03.B.1, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System





SECTION 09265

GYPSUM BOARD SHAFT-WALL ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for shaft wall and chase wall enclosures.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 09253 - Gypsum Sheathing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. SCAQMA: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
 - 3. STC: Sound transmission class.
 - 4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.



C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members.
 - c. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - d. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - e. ASTM C 840 - Standard Specification for Application and Finishing of Gypsum Board.
 - f. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - g. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.
 - h. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - i. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - j. ASTM E 413 - Classification for Rating Sound Insulation.
 - k. ASTM E 488 – Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - l. ASTM E 1190 – Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
5. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
6. Institute for Sustainability Infrastructure (ISI):



- a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:

- 1. Install sound attenuation blankets before installing gypsum panels, unless the blankets can be readily installed after the gypsum panels have been installed on one side of a partition.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Gypsum board shaft-wall assemblies.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied sealant used.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Gypsum board shaft-wall assembly manufacturer's published installation instructions.
- b. Manufacturer's Reports:
 - 1) Gypsum board shaft-wall assembly manufacturer's written recommendations for auxiliary materials.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

1.05 QUALITY ASSURANCE

- A. Not Used

1.06 NOT USED DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials in their original packages, containers, or bundles bearing the brand name and identification of the manufacturer or supplier.
- B. Storage and Handling Requirements:
 1. Stack panels flat, with spacers between each bundle to provide air circulation.
 - a. Furnish air circulation around the stacks and under coverings.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Ventilation:
 - a. Ventilate building spaces as required to remove water in excess of that required for drying joint treatment material immediately after its application.
 - b. Avoid drafts during dry, hot weather to prevent too rapid drying.
 2. Cold Weather Protection:
 - a. When ambient outdoor temperatures are below 55 degrees Fahrenheit, maintain continuous, uniform comfortable building working temperatures not less than 55 degrees Fahrenheit and not more than 70 degrees Fahrenheit for a minimum of 48 hours prior to, during, and



following installation of gypsum board and joint treatment materials or bonding of adhesives.

B. Existing Conditions:

1. Comply with the installation requirements for the conditions existing at the Site as specified in ASTM C 840, or with the gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 PRODUCTS

2.01 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
2. ENVISION Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide sealants and sealant primers for the gypsum board assemblies of this Contract having volatile organic compound content falling at or below the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Drywall and panel adhesives: 50 grams per Liter less water.
 - b. Recycled Content:
 - 1) Gypsum Panel Products:
 - a) Provide Gypsum board products that contain the maximum available recycled content that still comply with Regional Content requirements outlined in this section.



- 2) Steel Sheet:
 - a) Provide steel sheet having an average recycled content so the postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 75 percent.
 - 3) Sound Attenuation Blankets:
 - a) Provide sound attenuation blankets having a recycled content so the postconsumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 20 percent by weight.
 - b) All sound attenuation blankets shall contain no added urea formaldehyde.
 - c. Regional Content
 - 1) Provide Gypsum board products whose raw materials have been extracted, harvested, or recovered within 500 miles of the project site and have been manufactured within 500 miles of the project site.
- C. Performance:
- 1. Fire-Test-Response Characteristics:
 - a. For gypsum board shaft-wall assemblies required to have fire-resistance ratings, provide materials and construction identical to those of assemblies that have had their fire-resistance ratings determined by testing performed by an independent testing and inspecting agency acceptable to the Authorities Having Jurisdiction in accordance with the methods specified in ASTM E 119.
 - b. Fire-Resistance Rating:
 - 1) Provide gypsum board shaft-wall assemblies having the fire-resistance rating indicated on the Contract Drawings.
 - 2. Sound Transmission Class (STC) Rated Assemblies:
 - a. For gypsum board shaft-wall assemblies required to have sound transmission class (STC) ratings, provide materials and construction identical to those of assemblies that have had their sound transmission class (STC) ratings determined by testing performed by an independent testing and inspecting agency in accordance with the method specified in ASTM E 90 and classified in accordance with the method specified in ASTM E 413.
 - b. Sound Transmission Class (STC) Rating:
 - 1) Provide gypsum board shaft-wall assemblies having the sound transmission class (STC) rating indicated on the Contract Drawings.

D. Design Criteria:



1. Gypsum Board Shaft-Wall Assemblies:
 - a. Provide materials and components complying with requirements of the fire-resistance-rated gypsum board shaft-wall assemblies indicated on the Contract Drawings.
 - 1) Eliminate or minimize end-to-end butt joints by providing panels having the maximum lengths available.
 - 2) Provide auxiliary materials complying with the referenced product standards and the gypsum board shaft-wall assembly manufacturer's recommendations.
 - a) Submit the gypsum board shaft-wall assembly manufacturer's written recommendations for auxiliary materials to the Program/Project Manager for information.
2. Product Data:
 - a. Obtain the gypsum board shaft-wall assembly manufacturer's Product Data for each gypsum board shaft-wall assembly proposed for the Work of this Section.
 - b. Submit the Product Data for each gypsum board shaft-wall assembly to the Program/Project Manager for approval.

E. Materials:

1. Panel Products:
 - a. Gypsum Liner Panels:
 - 1) Provide gypsum liner panels complying with the requirements for Type X gypsum board specified in ASTM C 1396/C 1396M.
 - a) Provide the manufacturer's proprietary liner panels having moisture-resistant paper faces.
 - b) Core:
 - (1) Provide gypsum liner panels having a 1 inch (25.4mm) thick core.
 - c) Long Edges:
 - (1) Provide gypsum liner panels having a double bevel on their long edges.
 - b. Gypsum Board:
 - 1) Provide gypsum board complying with the requirements specified in Section 09253, Gypsum Sheathing.
 - c. Manufacturers:
 - 1) Georgia-Pacific Gypsum., <https://www.gp.com>.
 - 2) National Gypsum Company, <http://www.nationalgypsum.com>.
 - 3) PABCO Building Products LLC, PABCO® Gypsum, <http://www.pabco gypsum.com>.
 - 4) USG Corporation, <http://www.usg.com>.
 - 5) Approved equal.



2. Non-Load-Bearing Framing:
 - a. Framing Members:
 - 1) Provide non-load-bearing steel framing complying with the requirements specified in ASTM C 754 for the conditions indicated in the Contract Documents.
 - b. Steel Sheet Components:
 - 1) Unless otherwise indicated in the Contract Documents, provide steel sheet components complying with the requirements for metal and thicknesses specified in ASTM C 645.
 - 2) Protective Coating:
 - a) Unless otherwise indicated in the Contract Documents, provide steel sheet hot-dip galvanized in accordance with the requirements for G60 (Z180) protective coatings specified in ASTM A 653/A 653M.
 - c. Studs:
 - 1) For repetitive members, corner and end members, and the fire-resistance-rated assembly indicated in the Contract Documents, provide the manufacturer's standard profile studs having the depth and base-metal thickness indicated in the Contract Documents.
 - a) If no base-metal thickness is indicated in the Contract Documents, provide a base-metal thickness of at least 0.0220 inch (0.55mm).
 - d. Runner Tracks:
 - 1) Provide the manufacturer's standard J-profile track having the manufacturer's standard long-leg length, but not less than 2 inches (51mm) long and matching the depth of the studs and having a base-metal thickness at least as thick as the studs.
 - e. Firestop Tracks:
 - 1) To isolate the partition framing from the structure above in specific fire-resistance-rated assemblies, provide firestop tracks having a top runner manufactured to allow the partition heads to expand and contract with the movement of the structure while maintaining the continuity of fire-resistance-rated assembly indicated in the Contract Documents; and having a thickness not less than the thickness of the studs and a width to accommodate the depth of studs as indicated in the design designations of the assemblies on the Contract Drawings.
 - 2) Manufacturers:
 - a) Metal-Lite, Inc.[™], a Division of Perfect Wall.net, "The System[®]", <http://www.metal-lite.net>.



- b) Dietrich Metal Framing, SLP-TRK® Systems,
<http://www.dietrichmetalframing.com>.
 - c) Fire Trak Corp., Fire Trak attached to the studs with Fire Trak Slip Clips, <http://www.firetrak.com>.
 - d) Approved equal.
 - f. Jamb Struts:
 - 1) For framing elevator hoistway entrances, provide the manufacturer's standard J-profile strut having a long-leg length of 3 inches (76 mm), a depth matching the stud's depth, and a thickness of at least 0.0329 inch (0.84mm).
- 3. Auxiliary Materials:
 - a. Trim Accessories:
 - 1) Provide cornerbead, edge trim, and control joints fabricated from the material and of the shapes specified in Section 09253, Gypsum Sheathing, and that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for the application indicated in the Contract Documents.
 - b. Gypsum Board Joint-Treatment Materials:
 - 1) Provide gypsum board joint-treatment materials complying with the requirements specified in Section 09253, Gypsum Sheathing.
 - c. Laminating Adhesive:
 - 1) Provide adhesive or joint compound recommended by the adhesive manufacturer for directly adhering gypsum face-layer panels to backing-layer panels in multilayer construction.
 - d. Steel Drill Screws:
 - 1) Unless otherwise indicated in the Contract Documents, provide steel drill screws complying with the requirements specified in ASTM C 1002.
 - e. Track Fasteners:
 - 1) Provide power-driven fasteners of the size and material required to withstand the loading conditions imposed on the shaft-wall assemblies without exceeding the allowable design stress of the track, fasteners, or structural substrates in which the anchors are embedded.
 - a) Expansion Anchors:
 - (1) Provide expansion anchors fabricated from corrosion-resistant materials; and having the capability to sustain, without failure, a load equal to 5 times the design load as determined by tests of the expansion anchors conducted by a qualified testing agency in accordance with the methods specified in ASTM E 488.



- b) Power-Actuated Anchors:
 - (1) Provide a power-actuated anchor fastener system of a type suitable for the application indicated in the Contract Documents; fabricated from corrosion-resistant materials; having the capability to sustain, without failure, a load equal to 10 times the design load as determined by tests of the power-actuated anchors conducted by a qualified testing agency in accordance with the methods specified in ASTM E 1190.
- f. Sound Attenuation Blankets:
 - 1) Provide sound attenuation blankets complying with the requirements for Type I blankets (blankets without membrane facing) specified in ASTM C 665, and produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 2) Fire-Resistance-Rated Assemblies:
 - a) Provide sound attenuation blankets complying with the fire-resistance requirements of the assembly for mineral-fibers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine areas and substrates to receive gypsum board shaft-wall assemblies for compliance with requirements and other conditions affecting performance, including welded hollow-metal frames, cast-in anchors, and structural framing.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the gypsum board shaft-wall assemblies.
- B. Demolition/Removal:
 - 1. Perform cutting, drilling, and fitting as required to install the gypsum board shaft-wall assemblies.



- a. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install gypsum board shaft-wall assemblies in accordance with the requirements for the fire-resistance-rated assemblies indicated in the Contract Documents and the gypsum board shaft-wall assembly manufacturer's installation instructions.
 1. For installing steel framing, comply with the requirements specified in ASTM C 754, except comply with the requirements for the framing spacing indicated in the Contract Documents.
 2. For applying and finishing gypsum board panels, comply with the requirements specified in Section 09253, Gypsum Sheathing.
 3. Submit the gypsum board shaft-wall assembly manufacturer's published installation instructions to the Program/Project Manager for information.
- B. Firestop Tracks:
 1. Where a fire-resistance-rated assembly is indicated and detailed on the Contract Drawings, install firestop tracks to maintain the continuity of the fire-resistance-rated assembly indicated.
- C. Control Joints:
 1. Install control joints at the locations indicated on the Contract Drawings, while maintaining the fire-resistance rating of the gypsum board shaft-wall assemblies and complying with the control joint spacing requirements specified in ASTM C 840.
- D. Insulation:
 1. Provide sound attenuation blankets to insulate the gypsum board shaft-wall assemblies.
- E. Finishes:
 1. Room-Side Finish:
 - a. Finish the room-side of the gypsum board shaft-wall assemblies as indicated on the Contract Drawings.
 2. Shaft-Side Finish:
 - a. Finish the shaft-side of the gypsum board shaft-wall assemblies as indicated on the Contract Drawings, or as required to produce the required fire resistive rating.
- F. Special Techniques:



1. In elevator shafts where the gypsum board shaft-wall assemblies cannot be positioned within 4 inches (102mm) of the shaft face of structural beams, floor edges, and similar projections into the shaft, install 1/2 inch (13mm) or 5/8 inch (16mm) thick gypsum board cants covering the tops of the projections.
 - a. No recesses are allowed, especially at steel beams.
 - b. Slope the cant panels at least 75 degrees from horizontal.
 - 1) Set the base edge of the panels in adhesive, and secure the top edges to the shaft walls using screws fastened to the shaft-wall framing at 24 inches (610mm) on center.
 - c. Where steel framing is required to support the gypsum board cants, install the framing at 24 inches (610mm) on center, and extend the studs from the projection to the shaft-wall framing.

G. Interface with Other Work:

1. Do not bridge architectural or building expansion joints with gypsum board shaft-wall assemblies.
 - a. Frame both sides of expansion joints with furring and other support as detailed on the Contract Drawings.
2. Install supplementary framing in the gypsum board shaft-wall assemblies around openings and as required to provide blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by the shaft-wall assembly framing.
 - a. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame as detailed on the Contract Drawings.
 - b. Where handrails directly attach to the gypsum board shaft-wall assemblies, provide an accurately positioned galvanized steel reinforcing strip having a base (uncoated) metal thickness of at least 0.0312-inch (0.79mm), and secured behind at least 1 gypsum board face-layer panel.
3. At penetrations in the shaft wall, maintain the fire-resistance rating of the shaft-wall assembly by installing supplementary steel framing around the perimeter of the penetration; and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items; as detailed on the Contract Drawings.
4. Isolate the perimeter of gypsum board panels from the building structure to prevent cracking of the gypsum board panels, while maintaining the continuity of the fire-rated construction.

H. Tolerances:



1. Install each framing member so the fastening surfaces do not vary more than 1/8 inch (3mm) from the plane formed by the faces of the adjacent framing.

3.04 REPAIR/RESTORATION

- A. Remove gypsum board panels that are wet, moisture damaged, or mold damaged, and replace the damaged panels by providing new, undamaged panels.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.05 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. During remainder of the construction period, protect installed gypsum board shaft-wall assemblies from damage due to the weather, condensation, direct sunlight, construction, and other causes.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





24th St and RCC Station
Finishes Clarification

Change from Emser
Strand to Mosa Tile in
24th St Unisex Bathrooms

SECTION 09300

TILE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for ceramic tiling, including porcelain, non-porcelain tile and quarry tile.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07920 - Joint Sealants.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties.
 - 2. construction, and operation of high performance green buildings.
 - 3. TCNA: An acronym for Tile Council of (North) America, Inc.
 - 4. VOC: An abbreviation for *volatile organic compounds*, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Standard tiling terms defined in ASTM C242 apply to the Work of this Section.
 - 2. Ceramic Tile: Tiles made from clay or a mixture of clay and other materials, then kiln-fired; these tiles can be split into two groups, porcelain tiles and non-porcelain tiles.
 - 3. Coefficient of Friction: The ratio of the horizontal component of force required to overcome or have a tendency to overcome friction to the vertical component of the object weight or normal force applied through the object which tends to cause the friction.
 - 4. PEI Wear Rating: A testing system devised by the Porcelain Enamel Institute (PEI) to rate the strength of the glaze applied to tile against scratching and wearing using numbers (1 being the least scratch and wear resistant, thru 5 being the most scratch and wear resistant) to rate the strength of the glaze on tile.



5. Non-Porcelain Tile: Ceramic tile made by natural red or white clay, sand, and water; typically finished with a durable glaze, then baked in a kiln to remove most of the water; and generally softer and easier to cut than porcelain tile, and usually carrying a PEI wear rating of 0 to 3. Non-porcelain tiles are sometimes referred to as “ceramic tiles” by themselves, separate from porcelain tiles.
6. Porcelain Process: The method of producing glazed ware by which a ceramic body and glaze are matured together in the same firing operation.
7. Porcelain Tile: A strong, vitreous, translucent ceramic mosaic tile or paver that is generally made by the dust-pressed method from dense porcelain (kaolin) clays and fired to temperatures typically between 1200 degrees Centigrade (2192 degrees Fahrenheit) and 1400 degrees Centigrade (2552 degrees Fahrenheit) during the porcelain process to remove almost all water and result in a tile that is dense, fine-grained, and smooth with a sharply formed face, usually impervious, and having colors of the porcelain type which are usually of a clear, luminous type, or a granular blend thereof.

C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI A108/A118/A136.1 - American National Standards Specifications for the Installation of Ceramic Tile.
 - 1) ANSI A108.01 – General Requirements: Subsurfaces and Preparations by Other Trades.
 - 2) ANSI A108.1A – Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar.
 - 3) ANSI A108.11 – Interior Installation of Cementitious Backer Units.
 - 4) ANSI A108.13 – Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone.
 - 5) ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation.
 - 6) ANSI A137.1 – American National Standard Specifications for Ceramic Tile.
2. ASTM International (ASTM):
 - a. ASTM C242 - Standard Terminology of Ceramic Whitewares and Related Products.
 - b. ASTM C648 - Standard Test Method for Breaking Strength of Ceramic Tile.
 - c. ASTM C1027 - Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile.
 - d. ASTM C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
3. City of Phoenix (COP):
 - a. Phoenix Building Code and Amendments.



4. International Code Council (ICC):
 - a. International Building Code (IBC) As Amended by the City of Phoenix.
5. South Coast Air Quality Management District (AQMD):
 - a. AQMD Rules and Regulations:
 - 1) Rule 1168 – Adhesive and Sealant Applications.
6. Tile Council of North America, Inc. (TCNA):
 - a. TCNA Handbook for Ceramic, Glass, and Stone Tile Installation.
 - 1) TCNA Handbook Method Number F113 – On-Ground Concrete, Ceramic Tile.
 - 2) TCNA Handbook Method Number W245 – Coated Glass Mat Water-Resistant Gypsum Backer Board, Ceramic Tile.
7. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Porcelain tile.
 - 2) Quarry tile.
 - 3) Setting materials.
 - 4) Grouting materials.
 - 5) Grout sealing materials.
 - 6) Elastomeric sealants.
 - b. Samples:
 - 1) Ceramic tile Samples
 - 2) Quarry tile Samples.
 - 3) Grout Samples.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Waterproofing manufacturer's written application instructions.
 - 2) Backer unit manufacturer's written installation instructions.
 - 3) Grout sealer manufacturer's written application instructions.

C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Sustainable Design Closeout Documentation:
 - 1) Low-Emitting Materials- Adhesives and Sealants, Submittal for ceramic tile.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Furnish extra tile materials that match and are from the same production runs as the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Tile and Trim Units:
 - (1) For each type, composition, color, pattern, and size of tile and trim units installed, furnish a quantity of full-size tile and trim units equal to 3 percent of the amount installed.

1.04 QUALITY ASSURANCE

- A. Sustainability Standards Certifications:
 1. Sustainable Adhesives and Sealants Submittal:
 - a. For the ceramic tile adhesives used for installing the interior ceramic tile system, submit Product Data, including a printed statement of their chemical components and volatile organic compound (VOC) content, signed by the product manufacturer certifying that these products qualify the Project to claim Low-Emitting Materials-Adhesives and Sealants, to the Program/Project Manager for information.
 - 1) Certify compliance with volatile organic compound (VOC) content specified by Rule 1168 in the AQMD Rules and Regulations.
- B. Site Samples:
 1. Ceramic Tile Samples:
 - a. Submit Samples for each type and composition of tile and for each color and finish required under this Section to the Program/Project Manager for approval.
 2. Grout Samples:
 - a. Submit grout color Samples of the manufacturer's full standard range to the Program/Project Manager for selection and approval.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:



1. During delivery, provide a protective covering over dry mortar and grout materials to prevent moisture damage and contamination.
- B. Storage and Handling Requirements:
 1. Tile Grout:
 - a. During storage and handling, provide a protective covering over grout materials to prevent moisture damage and contamination.
 - b. Store and precondition grout and grout materials in accordance with the grout manufacturer's requirements.
 - 1) Provide air conditioned storage if required.
 - c. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.
 2. Tile Mortar:
 - a. Store dry mortar in delivery containers on elevated platforms, under cover, and in a dry location.
 3. Do not use dry mortar or grout materials that have become damp.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 CERAMIC TILE

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 3. Product Options:
 - a. Product Data:
 - 1) Obtain Product Data for each type and size of ceramic tile, each type of grout and each type of sealer provided under this Section.
 - 2) Submit the Product Data to the Program/Project Manager for approval.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Code:



- 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Code and Amendments [International Building Code (IBC) As Amended by the City of Phoenix].
 2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior adhesives and sealers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, Subpart D; and that comply with Rule 1168 in the AQMD Rules and Regulations:
 - a) Ceramic Tile Adhesives: Not more than 65 grams per Liter less water.
 - b) Architectural Sealants: Not more than 250 grams per Liter less water.
 - c) Architectural Sealant Primers for Nonporous Substrates: Not more than 250 grams per Liter less water.
 - d) Architectural Sealant Primers for Porous Substrates: Not more than 775 grams per Liter less water.
 - b. Sustainability Credits:
 - 1) Provide adhesives for use within the ceramic tile system that are capable of qualifying the Project for Low-Emitting Materials-Adhesives and Sealants.
- C. Performance:
1. Abrasion Resistance:
 - a. Provide ceramic tile flooring having a Class III abrasion resistance when tested in accordance with the method specified in ASTM C1027.
 2. Breaking Strength:
 - a. Provide ceramic tile flooring having a breaking strength of at least 472 pounds•force when tested in accordance with the method specified in ASTM C648.
 3. Coefficient of Friction:
 - a. Provide ceramic tile flooring having the following average Coefficients of Friction when tested in accordance with the method specified in ASTM C1028 under the following test conditions:
 - 1) Using a Dry Neolite Surface: 0.69.
 - 2) Using a Wet Neolite Surface: 0.62.
 4. Scratch Hardness:
 - a. Provide ceramic tile flooring having a scratch resistance of 6 as measured on the Mohs scale.
- D. Design Criteria:
1. ANSI Ceramic Tile Standard:



- a. Provide Standard grade tile that complies with the requirements for the types, compositions, and other characteristics indicated herein as specified in ANSI A137.1.

E. Materials:

1. Unglazed Porcelain Ceramic Floor Tile (Tile Type CT-1):
 - a. Provide unglazed porcelain ceramic mosaic floor tile complying with the following requirements:
 - 1) Module Size:
 - a) Provide 12-inch by 24-inch (304.8mm by 609.6mm) ceramic floor tiles.
 - 2) Thickness:
 - a) Provide 2/5 inch (10.16mm) thick ceramic floor tile.
 - 3) Face:
 - a) Provide plain ceramic floor tile having cushion edges.
 - 4) Surface:
 - a) Provide slip-resistant ceramic floor tile having an abrasive admixture.
 - 5) Tile Color and Pattern:
 - a) Provide ceramic floor tile having the color and pattern selected by the Program/Project Manager from the manufacturer's full range.
 - 6) Grout Color:
 - a) Provide grout having the color selected by the Program/Project Manager from the manufacturer's full range.
 - 7) Trim Units:
 - a) Provide trim units coordinated with the sizes and coursing of the adjoining flat tile, where applicable, and matching the characteristics of the adjoining flat tile.
 - b) Provide shapes selected from the manufacturer's standard shapes as follow.
 - (1) Base Modules: Provide 3-inch by 12-inch modules.
 - (2) External Corners: For thin-set mortar installations, provide bullnose shapes the same size as the adjoining flat tile.
 - (3) Internal Corners:
 - (a) Provide field-buttet square corners.
 - (b) For coved base and cap applications, provide angle pieces designed to fit with the stretcher shapes.
 - b. Manufacturers:
 - 1) Basis-Of-Design: Emser Tile™ LLC, <http://www.emser.com/>.
 - a) Field tile and adjacent base:
 - (1) Style: Strand.
 - (2) Color: Biscuit.
 - b) Accent tile and adjacent base:



- (1) Style: Strand.
 - (2) Color: Olive.
 - 2) American Olean Corporation, <http://americanolean.com/>.
 - 3) Dal-Tile Corporation, Daltile®, <http://www.daltile.com>.
 - 4) Internacional de Cerámica S.A.B. de C.V. Derechos Reservados, Interceramic®, www.interceramicusa.com.
 - 5) Manufacturer providing an equivalent product approved by the Program/Project Manager.
2. Glazed Ceramic Wall Tiles – Stage 2 Only
 - a. Provide glazed, dry-pressed ceramic wall tiles with white body, in accordance with ANSI A137.1 class P4. Double-firing manufacturing process.
 - 1) Module Size: Provide 4-inch by 12-inch ceramic wall tiles.
 - 2) Thickness: Provide 0.31-inch thick ceramic wall tiles.
 - 3) Surface: Powdermatt
 - 4) Edge: Short, glazed edge
 - 5) Tile Color and Pattern:
 - a) Provide ceramic wall tile having the color and pattern selected by the Program / Project Manager from the manufacturer's full range.
 - 6) Grout Color:
 - a) Provide grout having the color selected by the Program / Project Manager from the manufacturer's full range.
 - b. Manufacturers:
 - 1) Basis-of-Design: Royal Mosa, www.mosa.com
 - a) Field tile
 - (1) Collection: Matt Collection
 - (2) Color: 15810 Plain Porcelain White
 - 2) Approved Equal.
3. Unglazed Quarry Floor Tile (Tile Type QT-1):
 - a. Provide unglazed quarry floor tile complying with the following requirements:
 - (1) External Corners: For thin-set mortar installations, provide bullnose shapes the same size as the adjoining flat tile.
 - (2) Internal Corners:
 - (a) Provide field-buttet square corners.
 - (b) For coved base and cap applications, provide angle pieces designed to fit with the stretcher shapes.
 - b. Manufacturers:
 - 1) Basis-Of-Design: Dal-Tile, <http://www.daltile.com/>.



- 2) Provide non-abrasive, smooth plain quarry floor tile and cove base in similar size, texture and color to match existing floor tile in the Dick Clark Kitchen area.
4. Setting Materials:
 - a. Primer:
 - 1) Provide one component VOC compliant primer.
 - 2) Manufacturers:
 - a) MAPEI Primer T by MAPEI Corporation, www.mapei.us.
 - b) Manufacturer providing an equivalent product approved by the Program/Project Manager.
 - b. Underlayment:
 - 1) Provide High Hydrated cement technology self-leveling underlayment.
 - 2) Manufacturers:
 - A) MAPEI Ultraplan Easy by MAPEI Corporation.
 - B) Manufacturer providing an equivalent product approved by the Program/Project Manager.
 - c. Cementitious Improved Adhesive:
 - 1) ISO 13007: Classification C2ES2P2 premium grade dry-set mortar.
 - 2) Manufacturers:
 - a) MAPEI Kerabond/Keralastic System by MAPEI Corporation.
 - b) Manufacturer providing an equivalent product approved by the Program/Project Manager.
5. Grout Materials:
 - a. Polymer-Modified Tile Grout:
 - 1) Provide polymer-modified tile grout complying with the requirements specified in ANSI A118.7 within ANSI A108/A118/A136.1.
 - 2) Manufacturers:
 - a) MAPEI Ultracolor Plus by MAPEI Corporation, www.mapei.us
 - b) Manufacturer providing an equivalent product approved by the Program/Project Manager.
 - b. Urethane Tile Grout:
 - 1) Provide pre-mixed, water based, urethane tile grout complying with the requirements specified in ANSI A118.3-UG epoxy standard.
 - 2) Manufacturers:
 - a) Bostik, Inc., Quartz Lock2®, www.bostik-us.com.
 - b) Manufacturer providing an equivalent product approved by the Program/Project Manager.
6. Grout Sealer Materials:



- a. Provide the manufacturer's standard silicone product for sealing grout joints that does not change the color or appearance of the grout.

2.02 ACCESSORIES

A. Elastomeric Sealants and Accessories:

1. Provide elastomeric sealants, primers, backer rods, and other sealant accessories complying with the following requirements and with the applicable requirements specified in Section 07920, Joint Sealants:
 - a. Provide sealants having a volatile organic compounds (VOC) content of 250 grams per Liter or less when calculated according to the method specified in 40 CFR 59, Subpart D (EPA Method 24).
 - b. Provide sealants approved by the tile manufacturer of the installed product.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. With the installer present, examine the substrates, areas, and conditions where ceramic tile will be installed for compliance with the requirements for installation tolerances and other conditions affecting the performance of installed tile.
 - a. Verify that the substrates for setting the tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and that comply with flatness tolerances required by ANSI A108.01 within ANSI A108/A118/A136.1 for the applications indicated in the Contract Documents.

B. Evaluation and Assessment:

1. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Blending:
 - a. If the tile exhibits color variations, before installing the tile either provide factory blended tile or blend the tiles at the Site.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the ceramic tile.

B. Surface Preparation:



1. For tile floors installed with adhesives or thin-set mortar, fill the cracks, holes, uneven tile areas from tile demolition work and depressions in the concrete substrates with an underlayment material recommended by the setting material manufacturer.
2. Where the substrates are indicated to receive waterproofing, apply a reinforced mortar bed complying with the requirements specified in ANSI A108.1A within ANSI A108/A118/A136.1, and sloped 1/4 inch per foot (1:50) toward drains.
 - a. Produce a waterproof membrane of uniform thickness and bonded securely to the substrate by installing the waterproofing in accordance with the requirements specified in ANSI A108.13 within ANSI A108/A118/A136.1, and in accordance with the waterproofing manufacturer's application instructions.
 - 1) Submit the waterproofing manufacturer's written application instructions to the Program/Project Manager for information.
3. Field-Applied Temporary Protective Coating:
 - a. If specified for the tile type or required to prevent the grout from staining or adhering to the exposed tile surfaces, precoat the tiles with a continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.
4. Backer Units:
 - a. Where backer units are required, provide cementitious backer units, and treat the joints between the units in accordance with the requirements specified in ANSI A108.11 within ANSI A108/A118/A136.1, and in accordance with the manufacturer's written installation instructions for the indicated application.
 - 1) Submit the backer unit manufacturer's written installation instructions to the Program/Project Manager for information.

3.03 INSTALLATION

- A. Install ceramic tile in accordance with the requirements specified in the TCNA Handbook for Ceramic, Glass, and Stone Tile Installation for the Tile Council of North America, Inc. (TCNA) installation methods specified in tile installation schedules in the Contract Documents.
 1. Comply with the parts of the ANSI A108 Series in ANSI A108/A118/A136.1 that are referenced in Tile Council of North America, Inc. (TCNA) installation methods, specified in the tile installation schedule(s), and that apply to the types of setting and grouting materials provided.
- B. Unless otherwise indicated in the Contract Drawings, extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions.



1. Terminate work neatly at obstructions, edges, and corners without disrupting the pattern or joint alignments.
- C. Accurately form intersections and returns.
 1. Cut and drill the tile without marring its visible surfaces.
 2. Carefully grind the cut edges of the tile abutting trim, finish, or built-in items for straight aligned joints.
 3. Fit the tile closely to electrical outlets, piping, fixtures, and other penetrations so their plates, collars, or covers will overlap the tile.
- D. Jointing Pattern:
 1. Unless otherwise indicated, lay the tile in a grid pattern.
 2. Lay out the tile work, and center the tile fields in both directions in each space or on each wall area.
 3. Lay out the tile work to minimize the use of pieces that are less than half of a tile.
 4. Unless otherwise indicated, provide uniform joint widths.
- E. Joint Widths:
 1. Unless otherwise indicated, install tile so the following joint widths are constructed as applicable:
 - a. Porcelain Wall and Floor Tile: 1/16 to 1/8 inch.
 - b. Porcelain Base: 1/16 to 1/8 inch.
 - c. Quarry Tile: 3/8 inch or match existing as required.
 - d. Lay out tile wainscots to the dimensions indicated, or to the next full tile beyond the dimensions indicated.
- F. Expansion Joints:
 1. Where indicated on the Contract Drawings, provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints.
 - a. Form the joints during installation of the setting materials, mortar beds, and ceramic tile.
 - b. Do not saw-cut joints after installing the ceramic tiles.
 2. Where joints occur in concrete substrates, provide joints in the tile surfaces directly above the joints in the substrates.
 3. Prepare the joints and apply sealants in accordance with the requirements specified in Section 07920, Joint Sealants.
- G. Grout Sealer:
 1. After applying cementitious grout to the joints in the ceramic tile floors, apply a grout sealer to the grouted joints in accordance with the grout-sealer manufacturer's application instructions.
 - a. Submit the grout sealer manufacturer's written application instructions to the Program/Project Manager for information.



2. As soon as grout sealer has penetrated the grout joints, remove excess grout sealer and the grout sealer on the ceramic tile faces by wiping with a soft cloth.

3.04 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Take steps to insure that installed ceramic tile is protected during subsequent construction activities.

3.06 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
 1. Schedule 09310-1 - Interior Floor Installation, Concrete Subfloor (Tile Type CT-1).
 2. Schedule 09310-1 - Interior Floor Installation, Concrete Subfloor (Tile Type QT-1).

END OF SECTION



Schedule 09310-1 - Interior Floor Installation, Concrete Subfloor (Tile Type CT-1)	
Tile Parameter	Requirement or Material
Tile Installation	For tile installed on a concrete subfloor with thin-set mortar comply with the requirements specified in TCNA F113 ⁽¹⁾ On-Ground Concrete Ceramic Tile.
Tile Type	Unglazed 12-inch by 24-inch texture finish porcelain floor tile.
Preparation	Waterproofing and anti-fracture membrane (MAPEI Primer T and Ultraplan Easy Underlayment).
Tile Mortar	Latex modified thin-set mortar (MAPEI Kerabond/Keralastic system).
Tile Grout	Polymer-modified grout (MAPEI Ultra color Plus).
1. TCNA Handbook for Ceramic, Glass, and Stone Tile Installation Method Number. 2. Basis-of Design: product by MAPEI Corporation	
Schedule 09310-1 - Interior Floor Installation, Concrete Subfloor (Tile Type QT-1) Dick Clark's	
Tile Parameter	Requirement or Material
Tile Installation	For tile installed on a concrete subfloor with thin-set mortar comply with the requirements specified in TCNA F113 ⁽¹⁾ On-Ground Concrete Ceramic Tile.
Tile Type	Unglazed 6-inch by 6-inch (match existing) quarry floor tile.
Preparation	Waterproofing and anti-fracture membrane (MAPEI Primer T and Ultraplan Easy Underlayment).
Tile Mortar	Latex modified thin-set mortar (MAPEI Kerabond/Keralastic system).
Tile Grout	Epoxy-modified grout (MAPEI Kerapoxy).
3. TCNA Handbook for Ceramic, Glass, and Stone Tile Installation Method Number. 4. Basis-of Design: product by MAPEI Corporation	

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	05/21/2019	N/A	2.01.E.2	Add Glazed Ceramic Wall Tile Info



SECTION 09450

RESINOUS MATRIX TERRAZZO FLOORING

PART 1 GENERAL

RFI Stations Terrazzo Updated
1917 Design Confirmation

Terrazzo Design has been
updated (see hyperlink)

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for thin set epoxy terrazzo flooring as shown on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. MSDS: Material safety data sheets.
 - 3. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Standard terrazzo terms defined in the NTMA Terrazzo Specifications and Design Guide apply to the Work of this Section.
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public’s health, safety, and welfare.
 - 2. Matrix: The ingredient in a terrazzo floor which acts as a binder to hold marble chips in position.
 - 3. pH: A measure of the acidity or basicity of a solution, and defined as the cologarithm of the activity of dissolved hydrogen ions (H⁺).



4. Resinous Matrix: A two component thermal setting resinous material for use as the matrix in thin-set terrazzo.
5. Terrazzo: Marble, granite, onyx, or glass chips embedded in a resinous matrix.

C. Reference Standards:

1. American Concrete Institute (ACI):
 - a. ACI 408R – Bond and Development of Straight Reinforcing Bars in Tension.
 - b. ACI 503R - Use of Epoxy Compounds with Concrete.
2. ASTM International (ASTM):
 - a. ASTM C 190 - Standard Test Method for Tensile Strength Hydraulic Cement Mortars [*withdrawn*].
 - b. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - c. ASTM C 241 - Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
 - d. ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
 - e. ASTM D 56 – Standard Test Method for Flash Point by Tag Closed Cup Tester.
 - f. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - g. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
 - h. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
 - i. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
 - j. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30C and 30C With a Vitreous Silica Dilatometer.
 - k. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - l. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. National Terrazzo and Mosaic Association, Inc. (NTMA):
 - a. NTMA Terrazzo Specifications and Design Guide.
6. South Coast Air Quality Management District (SCAQMD):



- a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
7. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>
8. United States Government:
 - a. Department of Defense (DOD):
 - 1) Military Specifications:
 - a) MIL-D-3134 – Deck Covering Materials.
 - b. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
9. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the concrete mix design for areas to receive epoxy resin matrix flooring so it is compatible with the terrazzo materials.
 - a. Do not use curing agents or other additives which could prevent bonding of the resinous matrix terrazzo flooring.
 2. Coordinate the tolerances for concrete floors in areas to receive epoxy resin matrix flooring with the tolerances required for proper installation of the terrazzo.
 - a. Insure the concrete subfloor has a steel trowel finished surface, and is level having a maximum variation not exceeding 1/4 inch in a 10-foot span.
 - 1) Terrazzo is not intended to level the substrate and will only follow the contour of the concrete slab.
 - b. Saw cut control joints between 12 hours and 24 hours after the structural concrete has been placed.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Epoxy resin matrix flooring.
 - b. Shop Drawings:
 - 1) Epoxy resin matrix flooring.
 - c. Samples:
 - 1) Terrazzo Samples.
 - 2) Divider strip Samples.



- d. Certificates:
 - 1) Resinous Matrix Terrazzo Material Certificate of Compliance.
 - e. Qualification Statements:
 - 1) Terrazzo flooring installer's qualifications.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Epoxy resin manufacturer's instructions and recommendations for substrate preparation.
 - 2) Epoxy resin manufacturer's instructions and recommendations for proportioning mixes, installing strips, and placing, curing, grinding, and finishing the resinous matrix terrazzo flooring.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - 1) ENVISION Credit RA 1.3 - Use Recycled Materials
 - a) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. ENVISION Credit RA 1.4 – Use Regional Materials
 - 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
 - c. Floor Systems
 - 1) Submit product data highlighting the VOC content for any field applied floor sealants, stains or finishes used.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Instructions detailing the recommended periodic maintenance for each type of terrazzo.
 - b. Warranty Documentation:
 - 1) Resinous Matrix Terrazzo Flooring Materials Warranty
 - 2) Resinous Matrix Terrazzo Flooring Installation Warranty



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Terrazzo Flooring Installer's Qualifications:

- a. Engage an experienced terrazzo flooring installer who is a member of the National Terrazzo and Mosaic Association, Inc. (NTMA), and has within the past 5 years completed terrazzo installations similar in material and extent to that required for this Contract.
- b. Submit the terrazzo flooring installer's qualifications to the Program/Project Manager for approval.

B. Certifications:

1. Supplier/Manufacturer's Certificates of Compliance:

- a. Resinous Matrix Terrazzo Material Certificate of Compliance:
 - 1) Submit a written resinous matrix terrazzo material Supplier/manufacturer's Certificate of Compliance, certifying that the resinous matrix terrazzo materials being provided meet or exceed the specified requirements and the properties specified by the National Terrazzo and Mosaic Association, Inc. (NTMA) in the NTMA Terrazzo Specifications and Design Guide, to the Program/Project Manager for approval.

C. Site Samples:

1. Terrazzo Samples:

- a. Submit 3 Samples of each color and type of terrazzo flooring specified, each terrazzo Sample sized 6 inches long by 6 inches wide by 3/8 inch thick, to the Program/Project Manager for approval.

2. Divider Strip Samples:

- a. Submit 2 Samples of each type and kind of divider strip specified, each divider strip Sample 6 inches in length, to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Furnish properly labeled Material Safety Data Sheets (MSDS) complying with the current requirements of the State and Federal regulations for the materials delivered at the time of delivery.

B. Storage and Handling Requirements:

1. Comply with the resinous matrix terrazzo manufacturer's requirements for storing resinous matrix terrazzo materials.
2. Store resinous matrix terrazzo flooring material in a clean, dry, heated location maintained at a minimum temperature of 50 degrees Fahrenheit.

C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Manufacturer Warranty:
 1. Warrant the resinous matrix terrazzo flooring materials against failures within the 2-year period after the Date of Substantial Completion:
 - a. Submit a Resinous Matrix Terrazzo Flooring Materials Warranty on the manufacturer's standard or customized form, without monetary limitation, in which the manufacturer agrees to replace resinous matrix terrazzo flooring materials that fail within the specified warranty period to the Program/Project Manager for approval.
- B. Special Warranty:
 1. Installer's Warranty:
 - a. Warrant the resinous matrix terrazzo flooring workmanship against failures within the 2-year period after the Date of Substantial Completion:
 - 1) Submit a Resinous Matrix Terrazzo Flooring Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair resinous matrix terrazzo flooring that fails within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 RESINOUS MATRIX TERRAZZO SYSTEMS

- A. Manufacturers:
 1. The following products shall be procured from one manufacturer to ensure a complete and compatible terrazzo system:
 - a. Epoxy Resin Matrix Terrazzo
 - b. Penetrating Sealer
 - c. Epoxy Terrazzo Resin Primer
 - d. Underlayment
 - e. Underlayment Primer/Moisture Barrier
 - f. Epoxy Resin Crack Isolation Membrane.
 2. Manufacturer List:
 - a. General Polymers
 - b. Key Resin
 - c. Terrazzo & Marble Supply
 - d. Approved Equal
 3. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).

2. Sustainability Requirements:

a. Recycled Content

- 1) Terrazzo Flooring – Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.

b. Regional Content

- 1) Terrazzo Flooring – Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

c. Volatile Organic Compounds (VOC) Content of Floor Sealants, Stains and Finishes:

- 1) Provide sealants, stains and finishes for the Terrazzo Flooring of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1113:
 - a) Drywall and panel adhesives: 50 grams per Liter less water.

C. Performance:

1. Epoxy Resin Matrix:

- a. Provide epoxy resin matrix having the following properties when mixed in accordance with the manufacturer's recommendations and tested without the aggregate added:

1) Flammability:

- a) Provide finished epoxy terrazzo that is self-extinguishing, and has a maximum extent of burning of 0.25 inches when tested in accordance with the method specified in ASTM D 635.

2) Thermal Coefficient of Linear Expansion:



- a) Provide finished epoxy terrazzo having a thermal coefficient of linear expansion within the temperature range between negative 12 degrees Fahrenheit to 140 degrees Fahrenheit of 25×10^{-6} inch-degree-Fahrenheit when tested in accordance with the method specified in ASTM D 696.
- 3) Bond Strength:
 - a) Provide finished epoxy terrazzo having a minimum tensile bond strength of 300 psi, with 100 percent concrete failure, when tested in accordance with the Field Test for Surface Soundness and Adhesion specified in Appendix A.1 of ACI 503R.

D. Design Criteria

- 1. Provide epoxy resin matrix flooring complying with the provisions and recommendations specified in the NTMA Terrazzo Specifications and Design Guide.
- 2. Terrazzo Selection:
 - a. Provide a matrix color and aggregate (sprinkle) blend to be selected by the Program/Project Manager.
- 3. Product Data:
 - a. Obtain Product Data for the resinous matrix terrazzo flooring, including the manufacturer's specifications, design data, and installation instructions.
 - b. Submit the epoxy resin matrix flooring Product Data to the Program/Project Manager for approval.
- 4. Shop Drawings:
 - a. Prepare Shop Drawings of the resinous matrix terrazzo flooring showing the layout of divider strips, control joint strips, and base and border strips, and typical strip details.
 - b. Submit the epoxy resin matrix flooring Shop Drawings to the Program/Project Manager for approval.

E. Materials:

- 1. Colorants:
 - a. Provide epoxy/urethane color-stable pigment colorants.
- 2. Epoxy Resin Matrix:
 - a. Provide epoxy resin matrix having the following properties when test samples are mixed in accordance with the manufacturer's recommendations, cured for 7 days prior to the test in an environment having a temperature maintained at 75 degrees Fahrenheit plus or minus 2 degrees Fahrenheit and having a relative humidity of 50 percent plus or minus 2 percent, and tested without aggregate added:
 - 1) Hardness:
 - a) Provide epoxy resin matrix having a hardness between 60 and 80 when measured with a Type D Durometer in accordance with the method specified in ASTM D 2240.

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Stations Terrazzo Grout
Confirmation

Clear Casting Epoxy
acceptable to use at
intricate detailing



- 2) Tensile Strength:
 - a) Provide epoxy resin matrix having a minimum tensile strength of 3000 psi when tested in accordance with the method specified in ASTM D 638 using a 0.2 inch thick test sample made using a Standard Dumbbell Die C complying with the requirements specified in ASTM D 412.
- 3) Compressive Strength:
 - a) Provide epoxy resin matrix having a minimum compressive strength of 10,000 psi when cylindrical test samples are tested in accordance with the method specified in ASTM D 695.
- 4) Chemical Resistance:
 - a) Provide epoxy resin matrix showing no deleterious effects when tested using the following contaminants in accordance with the method specified in ASTM D 1308:
 - (1) Distilled water.
 - (2) Mineral water.
 - (3) Isopropanol.
 - (4) Ethanol.
 - (5) A 0.025 percent detergent solution.
 - (6) A 1 percent soap solution.
 - (7) A 10 percent sodium hydroxide solution.
 - (8) A 10 percent hydrochloric acid.
 - (9) A 30 percent sulfuric acid solution.
 - (10) A 5 percent acetic acid solution.
3. Epoxy Resin Primer:
 - a. Provide the epoxy resin primer by a manufacturer in accordance with section 2.01.A.2.
4. Marble Chips:
 - a. Provide marble chips containing no deleterious or foreign matter, having dust content less than 1 percent by weight, and having the following additional properties:
 - 1) Size:
 - a) Provide marble chips graded in accordance with Table 09450-1 and the National Terrazzo and Mosaic Association, Inc. (NTMA) graduation standards.

Table 09450-1 Marble Chip Gradation for Terrazzo		
NTMA Number	Screen Size Passing Chips (Inch)	Screen Size Retaining Chips (Inch)
0	1/8	1/16
1	1/4	1/8
2	3/8	1/4



- b) For 1/4 inch thick epoxy terrazzo, provide NTMA Number 0 and NTMA Number 1 marble chips.
 - c) For 3/8 inch thick epoxy terrazzo, provide NTMA Number 0, NTMA Number 1, and NTMA Number 2 marble chips.
 - b. Absorption Rate:
 - 1) Provide marble chips having a 24-hour absorption rate not exceeding 0.75 percent.
 - c. Abrasive Hardness Value (H_a):
 - 1) Provide marble chips having a minimum abrasive hardness value of 10 when tested in accordance with the method specified in ASTM C 241.
- F. Mixes:
 - 1. Epoxy Resin Matrix Terrazzo:
 - a. Provide 1 volume of epoxy resin matrix mixed in accordance with the manufacturer's recommendations, and blend it with 3 volumes of aggregate.

2.02 ACCESSORIES

- A. Epoxy Resin Crack Isolation Membrane:
 - 1. Provide 100% coverage of the entire area to receive Epoxy Terrazzo Flooring with the epoxy resin crack isolation membrane and fiberglass scrim recommended by the epoxy terrazzo resin matrix Supplier.
 - 2. Manufacturers:
 - a. In accordance with section 2.01.A.2.
- B. Sealers:
 - 1. Provide sealers that will not discolor or amber, that have a pH factor between 7 and 10, and that have a minimum flash point of 80 degrees Fahrenheit when tested in accordance with the method specified in ASTM D 56.
 - 2. Provide sealers that are UL-listed as "slip resistant".
 - 3. Penetrating Sealer:
 - a. Provide a solvent based acrylic penetrating sealer.
 - b. Manufacturers:
 - 1) In accordance with section 2.01.A.2
 - 4. Hard Surface Seal:
 - a. Provide a water-based acrylic sealer for terrazzo floors.
 - b. Manufacturers:
 - 1) Key Resin Co., Key #801 Acrylic Sealer, www.keyresin.com.
 - 2) Crossfield Products, Dex-O-Tex Clearseal 14, www.dexotex.com
 - 3) Approved equal.
 - 5. Sealer/Finish:
 - a. Provide a synthetic polymer finisher.



- b. Manufacturers:
 - 1) Johnson Wax Professional, JohnsonDiversey, Inc., Plaza™ Plus, www.diversey.com.
 - 2) Approved equal.
- C. Divider Strips:
 - 1. For stop and divider strips, provide “L” divider strips fabricated from aluminum; and having a depth of 3/8 inch and a topping of 1/8 inch heavy top.
 - 2. For expansion joints, provide double 16 gauge “L” strips fabricated from a white alloy of aluminum, laid back-to-back 1/4 inch apart with a flexible sealant insert, and having a 3/8 inch depth.
- D. Terrazzo Cleaner:
 - 1. Provide biodegradable and phosphate free terrazzo cleaner having a pH factor between 7 and 10.
- E. Underlayment:
 - 1. Provide an epoxy fill material, that when mixed with the proper proportion of silica aggregate will produce a high strength slurry or dry-pack mortar suitable for installation as a flooring underlayment and leveling compound for both interior and exterior applications.
 - a. Provide sufficient underlayment material to achieve the required substrate flatness and ensure finished floor elevations will match contract drawings.
 - b. Provide Bid allowance for an average of 1/2” thick underlayment material for the entire terrazzo work area.
 - 1) Segregate the underlayment bid allowance as such:
 - a) Provide one bid allowance assuming an average 1/4” thick underlayment (1/2” max. thickness)
 - b) Provide a second bid allowance assuming an additional 1/4” thick underlayment for entire terrazzo work area.
 - 2. Provide an underlayment compound capable of being applied to produce underlayments, and capable of being feathered down to a near zero edge.
 - 3. Provide an underlayment compound capable of being applied at temperatures as low as 50 degrees Fahrenheit (10 degrees Celsius).
 - 4. Provide an underlayment compound having the physical properties at 75 degrees Fahrenheit (24 degrees Celsius) indicated in Table 09450-2.

Table 09450-2 Underlayment Properties		
Property	Test Method	Acceptable Result
Compressive Strength	ASTM C 109	8,210 psi
Tensile Strength	ASTM C 307	2,000 psi



Table 09450-2 Underlayment Properties		
Property	Test Method	Acceptable Result
Flexural Strength	ASTM C 580	1,200 psi
Water Absorption	ASTM D 570	0.010%
Bond Strength to Concrete	COMM #403	300-400 psi (100% concrete failure)

5. Manufacturers:

- a. In accordance with section 2.01.A.2

F. Underlayment Primer/Moisture Barrier:

1. For substrates having moisture vapor transmission greater than 15 pounds per 1000 square feet in a 24 hour period, provide an underlayment primer to eliminate the transmission that is compatible with the underlayment.
2. Manufacturers:
 - a. In accordance with section 2.01.A.2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Examine the concrete substrate to ensure that the surface level is within the terrazzo floor finished surface flatness tolerance range specified in the NTMA Terrazzo Specifications and Design Guide for the type of terrazzo application specified.

B. Evaluation and Assessment:

1. Notify the Program/Project Manager of unsatisfactory level tolerances.
2. Do not begin installing the resinous matrix terrazzo flooring until unsatisfactory tolerances have been corrected and are ready to receive terrazzo.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage that could otherwise result from installation of the resinous matrix terrazzo flooring.

B. Surface Preparation:

1. Comply with the resin manufacturer's instructions and recommendations for substrate preparation.



- a. Submit the resin manufacturer's instructions and recommendations for substrate preparation to the Program/Project Manager for information.
2. Modify or replace concrete that has not been properly placed and has excessive honeycombing, cracking, or other defects.
 - a. Provide materials to correct slab non-conformities that are compatible with the terrazzo system and approved by the terrazzo installer.
3. Clean and prepare the substrate in accordance with the requirements specified in the NTMA Terrazzo Specifications and Design Guide for the type of terrazzo being installed.
 - a. Broom-clean the substrate to remove loose chips, laitance, and foreign matter.
 - b. Clean and prepare concrete substrate using a shot blasting or grinding and polishing cleaning machine as applicable.
 - c. Crack Repair:
 - 1) After cleaning the concrete substrate, rout any cracks that are 1/16 inch or more wide to create a "V" shaped groove.
 - 2) Insert concrete pins to hold the cracks open.
 - 3) Pour self-leveling 100 percent solids epoxy into the cracks.
 - d. After crack repair epoxy has cured, apply anti-fracture membrane as required.
 - e. Fill holes in the floor with an epoxy filler as required.
4. Underlayment:
 - a. Provide underlayment in areas requiring additional leveling.
 - b. Clean the surface so it is free of dirt, grease, oil, curing agents, and other foreign matter.
 - c. Prime surfaces that do not meet the moisture vapor transmission limitations.
 - d. Trowel the properly proportioned and mixed underlayment into a tight smooth surface.
 - 1) For underlayments greater than 1/2 inch thick, apply multiple layers.
 - e. Allow the underlayment to cure for at least 12 to 18 hours per 1/2 inch of underlayment depth.

3.03 INSTALLATION

- A. Comply with the epoxy resin manufacturer's recommendations for proportioning mixes, installing strips, and placing, curing, grinding, and finishing the resinous matrix terrazzo flooring.
 1. Where required by Site conditions, apply a 40-mil thick crack isolation membrane in accordance with the manufacturer's instructions.
 2. Prime the subfloor in accordance with resinous matrix terrazzo flooring manufacturer's recommendations.
 3. Provide epoxy resin matrix mixed according to manufacturer's recommendations and blended with the marble chips.
 4. Place the terrazzo mixture into panels formed by divider strips.



5. Finish the terrazzo mixture to a nominal 3/8 inch thickness.
 - a. Trowel the mixture to the top of the divider strips.
 6. Submit the epoxy resin manufacturer's instructions and recommendations for proportioning mixes, installing strips, and placing, curing, grinding, and finishing the resinous matrix terrazzo flooring to the Program/Project Manager for information.
- B. Divider Strips:
1. Provide divider strips installed using construction adhesive as shown on the Contract Drawings directly above control joints in the sub-floor, and where necessary to prevent irregular cracking.
 2. Provide control joints for the resinous matrix terrazzo flooring directly over control joints in the subfloor by placing angle-type divider strips back-to-back 1/4 inch apart, and provide flexible filler between the divider strips, flush with the finish floor.
- C. Curing:
1. Cure the terrazzo in accordance with the epoxy resin manufacturer's recommendations.
 2. Allow a 24 hours cure time before finishing the terrazzo.
- D. Finishing:
1. Rough Grinding:
 - a. Grind the terrazzo using 24-grit or finer stones, or with comparable diamond plugs.
 - b. Follow-up the initial grind by grinding the terrazzo using 80-grit or finer stones.
 2. Grouting:
 - a. Clean the terrazzo with clean water, rinse, and allow the terrazzo to dry.
 - b. Apply grout having the identical color used in the epoxy colored matrix topping, insuring that all voids are filled.
 - c. Allow the grout to cure for a minimum of 24 hours.
 3. Fine Grinding:
 - a. Grind the grouted terrazzo using 80-grit or finer stones until all of the grout is removed from the surface.
 - b. Upon completion of the fine grinding, verify that the terrazzo shows a minimum of 70 percent of marble chips.
- E. Cleaning and Sealing:
1. Wash the terrazzo surfaces using a neutral cleaner.
 2. Rinse the terrazzo with clean water, and allow the surfaces to dry.
 3. Apply sealer in accordance with sealer manufacturer's recommendations.
 4. After the initial sealing operations are completed, clean the terrazzo in accordance with the sealer manufacturer's recommendations.



5. Apply 2 coats of acrylic hard surface seal in accordance with the hard surface seal manufacturer's recommendations.
6. Apply 2 coats of deep gloss acrylic liquid finisher to cleaned terrazzo surfaces in accordance with the deep gloss acrylic liquid finisher manufacturer's instructions, and buff the resinous matrix terrazzo flooring to obtain the desired sheen.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Inspections:
 - a. Upon completion of the resinous matrix terrazzo flooring Work, notify the Program/Project Manager that the work is ready for final inspection and acceptance.

3.05 CLEANING

A. Final Cleaning:

1. When the building is ready for occupancy, clean the terrazzo as recommended by the manufacturer of the sealer, and machine buff the terrazzo floor as required.

B. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- #### A. Protect the finished floor from damage and wear from the time that the terrazzo installer completes the work until the building is ready for occupancy.

3.07 MAINTENANCE

A. Maintenance Data:

1. Submit written instructions detailing the recommended periodic maintenance for each type of terrazzo to the Program/Project Manager.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 09514



ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. ENVISION Submittal:
 - 1. ENVISION Credit RA 1.3 - Use Recycled Materials
 - a. Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials
 - 2. ENVISION Credit RA 1.4 – Use Regional Materials
 - a. Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).
- C. Product test reports.
- D. Research/evaluation reports.
- E. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.
- B. Fire-Test-Response Characteristics:



1. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class **B** materials, when tested per ASTM E 84.
 - a. Smoke-Developed Index: 450 or less.

C. Seismic Standard: Comply with the following:

1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to 5 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANEL CEILINGS, GENERAL

A. Acoustical Panel Standard: Comply with ASTM E 1264.

1. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.

B. Metal Suspension System Standard: Comply with ASTM C 635.

1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than **25** percent.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69mm-) diameter wire.

E. Seismic perimeter stabilizer bars, seismic struts, and seismic clips.

F. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with



seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

Basis-of-Design Product: Subject to compliance with requirements, provide:

APC #1 Typical Perforated and Fissured Pattern: Units fitting ASTM E 1264 pattern designation CD, with other panel characteristics as follows:

1. Item Number: Armstrong #704 Cortega
2. Color/Light Reflectance Coefficient: White/LR 0.80
3. Noise Reduction Coefficient: NRC 0.55
4. Edge Detail: Angled tegular lay-in.
5. Size: 24" x 24" x 5/8"

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Armstrong Prelude XL 15/16" Exposed Tee System, Seismic Rx

B. Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24mm-) wide metal caps on flanges.

1. Structural Classification: **Heavy**-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Color: White

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where



width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

1. Do not attach hangers to steel deck tabs or to steel roof deck.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate at intervals not more than 16 inches (400mm) on center and not more than 3 inches (75mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2mm in 3.6m). Miter corners accurately and connect securely.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition



SECTION 09515

ACOUSTICAL METAL PAN CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for acoustical metal pan ceilings, including the following:
 - a. Metal ceiling panels.
 - b. Exposed grid suspension system.
 - c. Wire hangers, fasteners, main runners, cross tees, wall angle moldings and accessories.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Articulation class.
 - 2. CAC: Ceiling attenuation class.
 - 3. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 4. NRC: Noise reflection coefficient.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 641/A 641M – Standard Specification for Zinc-Coated (Galvannealed) Carbon Steel Wire.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - d. ASTM C 635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.



- e. ASTM C 636/C 636M – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
- f. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- g. ASTM E 580/E 580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.
- h. ASTM E 1111 - Standard Test Method for Measuring the Interzone Attenuation of Open Office Components.
- i. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products.
- j. ASTM E 1414 - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
- k. ASTM E 1477 - Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. Ceilings and Interior Systems Construction Association (CISCA):
 - a. CISCA Guidelines for Seismic Restraint for Direct-hung Suspended Ceiling Assemblies (zones 3-4).
 - b. CISCA Recommendations for Direct-hung Acoustical tile and Lay-in Panel Ceilings (zones 0-2).
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
- 6. United States Government:
 - a. United States Department of Commerce:
 - 1) National Institute of Standards and Technology (NIST):
 - a) NIST Handbook 150 – National Voluntary Laboratory Accreditation Program (NVLAP) Procedures and General Requirements.
 - b) NIST Handbook 150-8 – National Voluntary Laboratory Accreditation Program (NVLAP) Acoustical Testing Services.
- 7. Underwriters Laboratories, Inc.® (UL):
 - a. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the ceiling Work of this Section with the installers of related work, including, but not limited to, building insulation, gypsum board, light



fixtures, mechanical systems, electrical systems, and fire suppression sprinklers.

- a. Coordinate the panel layout with mechanical and electrical fixtures.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Metal pan ceiling panels.
 - 2) Suspension system.
 - 3) Infill panels.
 - b. Shop Drawings:
 - 1) Layout drawings and details of acoustical metal pan ceilings.
 - c. Samples:
 - 1) Samples of the specified acoustical panel.
 - 2) Samples of the exposed wall molding and suspension system.
 - d. Certificates:
 - 1) Acoustical metal pan ceiling system manufacturer's Certificates of Compliance.
 - e. Qualification Statements:
 - 1) Qualifications of the Testing and Inspection Agency for verifying acoustical performance.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Acoustical metal pan ceiling system manufacturer's written installation instructions.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. ENVISION Credit RA 1.3 - Use Recycled Materials
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating at least 20% (by weight or volume) of materials used are from reclaimed or recycled materials.
 - b. Certified Wood
 - 1) Submit Chain of Custody (COC) certificates' indicating that new wood provided complies with Forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include



statement indicating cost for each certified wood product. If product is a mix of recycled content and new wood, provide breakdown by weight of each component and material values for each separately.

c. ENVISION Credit RA 1.4 – Use Regional Materials

- 1) Submit product data indicating location and distance from Project of material manufacture and point of extraction or harvest for each raw material. Include statement indicating at least 60% of all materials, plants, and soils are sourced within the
- 2) distances specified: soils (50 mi, 80 km), aggregate (50 mi, 80 km), concrete (100 mi, 160 km), plants (250 mi, 400 km), and all other materials (500 mi, 800 km).

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Warranty Documentation:

- 1) Acoustical Metal Pan Ceiling Warranty.

b. Sustainable Design Closeout Documentation:

- 1) Construction Waste Management: Divert 50% From Disposal, Submittal for acoustical metal pan ceilings.
- 2) Construction Waste Management: Divert 75% From Disposal, Submittal for acoustical metal pan ceilings.
- 3) Recycled Content: 10% (post-consumer + 1/2 pre-consumer), Submittal for acoustical metal pan ceilings.
- 4) Recycled Content: 20% (post-consumer + 1/2 pre-consumer), Submittal for acoustical metal pan ceilings.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Extra Stock Materials:

- 1) Furnish spare acoustical metal pan ceiling units that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.

a) Ceiling Units:

- (1) Furnish a spare quantity of full-size acoustical metal pan ceiling units equal to 5 percent of the quantity of acoustical metal pan ceiling units installed.

b) Exposed Suspension System Components:

- (1) Furnish a spare quantity of each exposed suspension component equal to 2 percent of the quantity of exposed suspension components installed.



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Testing and Inspection Agency's Qualifications:

- a. If required to perform acoustical performance testing, employ an independent laboratory certified under the National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) to conduct the testing indicated.
 - 1) The Testing and Inspection Agency to perform the acoustical performance testing required must comply with the requirements specified in NIST Handbook 150 and NIST Handbook 150-8.
 - 2) The independent Testing and Inspection Agency must be acceptable to the Authorities Having Jurisdiction.
- b. Submit the qualifications of the Testing and Inspection Agency for verifying acoustical performance to the Program/Project Manager for approval.

B. Certifications:

1. Acoustical Performance Certification:

- a. Each carton of material must carry an approved independent laboratory classification of the material's noise reflection coefficient (NRC), ceiling attenuation class (CAC), and articulation class (AC) for acoustical performance.
 - 1) Either provide materials having the Underwriters Laboratories, Inc. or Factory Mutual classification of its acoustical performance on every carton; or at the Program/Project Manager's discretion, send material from every production run appearing on the Site to an independent Testing and Inspection Agency for acoustical performance testing.
 - 2) Remove and dispose of products not conforming to manufacturer's current published values, and replace the removed materials with products complying with the specified requirements at no increase in the Contract Price.

2. Acoustical Metal Pan Ceiling System Manufacturer's Certificates of Compliance:

- a. Submit the acoustical metal pan ceiling system manufacturer's Certificates of Compliance, signed by the acoustical metal pan ceiling system manufacturer, and certifying that the acoustical metal pan ceiling system materials and finishes being provided comply with the specified requirements, to the Program/Project Manager for approval.
 - 1) Provide evidence, including laboratory reports, of the acoustical metal pan ceiling system's compliance with the specified tests and standards.

C. Site Samples:



1. Submit 6 inch by 6 inch Samples of the specified acoustical panel to the Program/Project Manager for approval.
2. Submit 8 inch long Samples of the exposed wall molding and suspension system, including a main runner and 4 foot cross tees, to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver system components in the manufacturer's original unopened, clearly labeled packages.
- B. Storage and Handling Requirements:
 1. Store the ceiling panels in a dry, interior location; and keep the ceiling panels in cartons prior to their installation to avoid damage.
 2. Exercise care in moving and opening cartons to prevent damage to the panel faces.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Do not install acoustical metal pan ceiling products with humidity resistant and hot-dipped galvanized steel, aluminum, or stainless steel suspension systems when the temperature exceeds 120 degrees Fahrenheit (49 degrees Celsius), or before the building is enclosed in spaces where heating, ventilating, and air-conditioning (HVAC) systems are cycled or not operating.

1.08 WARRANTY

- A. Manufacturer Warranty:
 1. Warrant the acoustical metal pan ceiling materials and workmanship against failures during the warranty period specified, including but not limited to the following:
 - a. Ceiling Panels:
 - 1) Warrant the acoustical metal pan ceiling panels against sagging and warping during the warranty period within 1 year from the Date of Substantial Completion.
 - b. Grid:
 - 1) Warrant the acoustical metal pan ceiling grid against rusting and manufacturer's defects during the warranty period within 10 years from the Date of Substantial Completion.



- c. Humidity Resistance:
 - 1) Warrant the acoustical metal pan ceiling system supplied by one source manufacturer against damage from humidity during the warranty period within 15 years from the Date of Substantial Completion.
- 2. Submit the written Acoustical Metal Pan Ceiling Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of acoustical metal pan ceiling that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.
 - b. The Acoustical Metal Pan Ceiling Warranty will be in addition to and run concurrently with other warranties made by the Contractor under the requirements of the Contract Documents.
 - c. The Acoustical Metal Pan Ceiling Warranty does not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents

PART 2 PRODUCTS

2.01 ACOUSTICAL METAL PAN CEILING SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain ceiling panel units and grid components from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 - 2. ENVISION Requirements:
 - a. Recycled Content



- 1) Provide Ceiling panels with combined post-consumer recycled content and one-half pre-consumer recycled content that is no less than 70 percent.
 - b. FSC Certification
 - 1) Provide wood materials that are procured through an FSC chain of custody from sustainably managed forests.
 - c. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide adhesives and sealants for the gypsum board assemblies of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Adhesives: 50 grams per Liter less water.
- C. Performance:
 1. Fire-Test-Response Characteristics:
 - a. Surface-Burning Characteristics:
 - 1) Provide acoustical metal pan ceilings complying with the requirements for Fire Class A materials specified in ASTM E 1264, and complying with the following requirements when tested in accordance with the method specified in ASTM E 84:
 - a) Flame Spread Index: 25 or less.
 - b) Smoke-Developed Index: 50 or less.
 - 2) Identify the surface-burning characteristics of the ceiling components using the appropriate markings of the applicable testing and inspecting organization.
 - a. Provide ceiling suspension systems complying with the seismic restraint requirements specified in ASTM E 580/E 580M, CISCA Guidelines for Seismic Restraint for Direct-hung Suspended Ceiling Assemblies (zones 3-4), and CISCA Recommendations for Direct-hung Acoustical tile and Lay-in Panel Ceilings (zones 0-2).
 2. Seismic Performance:
 3. Structural Performance: Exterior snap-in metal pan ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.
 - a. Wind Load: Uniform pressure as indicated on Drawings per the Building Code and SEI/ ASCE 7 criteria, acting inward or outward.
- D. Design Criteria:
 1. Acoustical Panels:
 - a. Provide acoustical panels complying with the requirements specified in ASTM E 1264.



- b. Do not provide acoustical metal pan ceiling products for exterior applications where standing water is present or where moisture will come in direct contact with the ceiling.
 - 2. Suspension System:
 - a. Structural Classification:
 - 1) Provide a double-web, metal suspension system complying with the requirements for the intermediate duty structural classification specified in ASTM C 635, and having a null type exposed flange design.
 - b. Attachment Devices:
 - 1) Unless otherwise indicated in the Contract Documents, size attachment devices for 5 times the design load indicated in "Table 1 - Direct Hung" in ASTM C 635.
 - 2) Comply with the specified seismic performance requirements.
 - a) Provide seismic perimeter stabilizer bars, seismic struts, and seismic clips.
 - c. Wire Hangers, Braces, and Ties:
 - 1) Select the wire diameter so its yield stress is at least 3 times the hanger design load, but do not provide wire having a diameters less than 12 gage.
 - d. Edge Moldings and Trim:
 - 1) Provide the type and profile of metal edge moldings and trim for edges and penetrations indicated in the Contract Documents; or, if the edge moldings and trim are not indicated, provide the manufacturer's standard moldings that comply with the seismic performance requirements.
 - a) Provide metal edge moldings having exposed flanges the same width as the exposed runners.
- 3. Product Data:
 - a. Obtain the manufacturer's technical Product Data for each type of ceiling unit and suspension system required.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- 4. Shop Drawings:
 - a. Prepare layout drawings and details of acoustical metal pan ceilings.
 - 1) Show the locations of items which are to be coordinated with, or supported by the ceilings.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.

E. Materials:

- 1. Metal Pan Ceiling Panels:
 - a. Provide smooth acoustical metal pan ceiling panels complying with the following requirements:
 - 1) Color/Light Reflectance Coefficient:



- a) Provide white acoustical metal pan ceiling panels having a light reflectance coefficient (LR) of 0.77 when measured in accordance with the method specified in ASTM E 1477.
- 2) Noise Reduction Coefficient (NRC):
 - a) Provide acoustical metal pan ceiling panels having a noise reduction coefficient (NRC) of 0.10 when measured in accordance with the method specified in ASTM C 423.
 - (1) Affix the acoustical metal pan ceiling panel's Underwriters Laboratories, Inc. classification label on product cartons.
- 3) Edge Profile:
 - a) Provide acoustical metal pan ceiling panels having flush tegular edge profiles for the interface with exposed tees.
- 4) Size:
 - a) Provide acoustical metal pan ceiling panels sized 24 inches by 24 inches by 5/8 inch.
- 5) Ceiling Attenuation Class (CAC):
 - a) Provide acoustical metal pan ceiling panels having a ceiling attenuation Class (CAC) of 36 when measured in accordance with the method specified in ASTM E 1414.
 - (1) Affix the acoustical metal pan ceiling panel's Underwriters Laboratories, Inc. classification label on product cartons.
- b. Manufacturers:
 - 1) Armstrong World Industries, Inc., basis of design MetalWorks Flush Tegular 9442U6A1, and Vector Exterior 6466M2SG2 <http://www.armstrong.com>
 - 2) Approved equal.
- 2. Suspension System:
 - a. Main Beams and Cross Tees:
 - 1) Provide commercial quality hot-dipped galvanized steel, aluminum, or stainless steel main beams and cross tees complying with the requirements specified in ASTM A 653/A 653M.
 - 2) Chemically cleanse exposed surfaces, and cap pre-finished galvanized steel, aluminum, or stainless steel in baked polyester paint.
 - 3) Except for extruded aluminum or stainless steel main beams and cross tees, rotary stitch the main beams and cross tees.
 - 4) Color:
 - a) Unless otherwise noted in the Contract Documents, provide white main beams and cross tees matching the actual color of the selected ceiling tile.
 - b. Wire Hangers, Braces, and Ties:
 - 1) Provide pre-stretched zinc-coated carbon-steel wire complying with the requirements specified for Class 1 zinc coating, soft temper wire in ASTM A 641/A 641M.



- c. Manufacturers:
 - 1) Armstrong World Industries, Inc., basis of design Prelude XL 15/16 inch Exposed Tee, and Prelude XL for Exterior Applications 15/16 inch Exposed Tee <http://www.armstrong.com>
 - 2) Approved equal.

2.02 ACCESSORIES

- A. Infill Panels:
 - 1. Provide a poly-wrapped fiberglass infill panel.
 - 2. Manufacturers:
 - a. Armstrong World Industries, Inc., basis of design Fiberflax Infill 8200100, <http://www.armstrong.com>
 - b. Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine areas receiving the acoustical metal pan ceiling system for conditions that might adversely affect the installation.
 - a. Verify that building areas to receive the ceilings are free of construction dust and debris.
 - b. Verify that all work above the ceiling system has been satisfactorily completed prior to beginning to install the ceiling.
 - 2. Measure each ceiling area, and establish the layout of the acoustical metal pan panels to balance the border widths at opposite edges of each ceiling.
 - a. Avoid using less-than-half-width panels at borders, and comply with the layouts on the approved reflected ceiling plans.
- B. Evaluation and Assessment:
 - 1. Do not begin to install the ceiling until unsatisfactory conditions affecting the ceiling systems have been corrected.
 - 2. Do not begin to install the ceiling until all wet work, such as concrete, terrazzo, plastering, and painting, has been completed and thoroughly dried out.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the acoustical panel ceilings.
- B. Demolition/Removal:



1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Provide the suspension system and panels in accordance with the requirements specified in ASTM C 636/C 636M and the manufacturer's installation instructions, and with the requirements of the Authorities Having Jurisdiction.
 1. Submit the acoustical metal pan ceiling system manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Suspension System:
 1. Hangers:
 - a. Suspend the main beams from the overhead construction using hanger wires spaced 4 feet on center along the length of the main runner.
 - 1) Install the hanger wires plumb and straight.
 - 2) Install the cross tees.
 2. Edge Moldings and Trim:
 - a. Install wall moldings at the intersections of the suspended ceiling and vertical surfaces.
 - b. Where wall moldings intersect, miter the corners or install corner caps.
- C. Acoustical Panels:
 1. Provide acoustical panels with undamaged edges, and fit them accurately into the suspension system main beams, cross tees, and edge moldings.
 2. Cut panels at the borders and penetrations to provide a neat, precise fit.

3.04 REPAIR/RESTORATION

- A. Replace damaged and broken ceiling panels with new undamaged panels.
- B. Clean and touch up minor damage to finishes in accordance with the manufacturer's instructions.
 1. Remove and replace ceiling panel Work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.05 CLEANING

- A. Clean the exposed surfaces of the ceilings panels, including the trim, edge moldings, and suspension members.
- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.06 PROTECTION

- A. Take steps to insure that installed acoustical panel ceilings are protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 09525

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for acoustical panels and exposed suspension systems for ceilings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. LR: Light reflectance coefficient.
 - 2. NRC: Noise reduction coefficient.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 641/A 641M – Standard Specification for Zinc-Coated (Galvannealed) Carbon Steel Wire.
 - b. ASTM A 653/A 653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM C 635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - d. ASTM C 636/C 636M – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - e. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - f. ASTM E 580/E 580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.



- g. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 3. Ceilings and Interior Systems Construction Association (CISCA):
 - a. CISCA Ceiling Systems Handbook.
 - b. CISCA Guidelines for Seismic Restraint for Direct-hung Suspended Ceiling Assemblies (zones 3-4).
 - c. CISCA Recommendations for Direct-hung Acoustical tile and Lay-in Panel Ceilings (zones 0-2).
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. United States Government:
 - a. United States Department of Commerce:
 - 1) National Institute of Standards and Technology (NIST):
 - a) NIST Handbook 150 – National Voluntary Laboratory Accreditation Program (NVLAP) Procedures and General Requirements.
 - b) NIST Handbook 150-8 – National Voluntary Laboratory Accreditation Program (NVLAP) Acoustical Testing Services.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the ceiling Work of this Section with the installers of related work, including, but not limited to, building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and fire suppression sprinklers.
 - a. Coordinate the panel layout with mechanical and electrical fixtures.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Acoustical ceiling panels.
 - 2) Metal suspension system.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Acoustical panel ceiling manufacturer's written installation
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Recycled Content
 - 1) Submit product data for recycled content indicating post-consumer recycled content and one-half pre-consumer recycled content for those products having recycled content. Include statement indicating material cost for each product and the fraction by weight that is considered recycled.
- C. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare acoustical ceiling panels that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Acoustical Ceiling Panels:
 - (1) Furnish a quantity of spare acoustical ceiling panels equal to 5 percent of the quantity of acoustical ceiling panels installed.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Testing and Inspection Agency's Qualifications:
 - a. If required to perform acoustical performance testing, employ an independent laboratory certified under the National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) to conduct the testing indicated.
 - 1) The Testing and Inspection Agency to perform the acoustical performance testing required must comply with the requirements specified in NIST Handbook 150 and NIST Handbook 150-8.
 - 2) The independent Testing and Inspection Agency must be acceptable to the Authorities Having Jurisdiction.
 - b. Submit the qualifications of the Testing and Inspection Agency for verifying acoustical performance to the Program/Project Manager for approval.
- B. Certifications:
 1. Acoustical Performance Certification:
 - a. Each carton of material must carry an approved independent laboratory classification of the material's noise reflection coefficient (NRC), ceiling attenuation class (CAC), and articulation class (AC) for acoustical performance.



- 1) Either provide materials having the Underwriters Laboratories, Inc. or Factory Mutual classification of its acoustical performance on every carton; or at the Program/Project Manager's discretion, send material from every production run appearing on the Site to an independent Testing and Inspection Agency for acoustical performance testing.
- 2) Remove and dispose of products not conforming to manufacturer's current published values, and replace the removed materials with products complying with the specified requirements at no increase in the Contract Price.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver system components in the manufacturer's original unopened, clearly labeled packages.
- B. Storage and Handling Requirements:
 1. Store the ceiling panels in a dry, interior location; and keep the ceiling panels in cartons prior to their installation to avoid damage.
 2. Exercise care in moving and opening cartons to prevent damage to the panel faces.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 ACOUSTICAL PANEL CEILING SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and



- Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
2. Sustainability Requirements:
 - a. Recycled Content:
 - 1) Acoustical Panels:
 - a) Provide acoustical panels with recycled content such that the postconsumer recycled content plus one-half of the preconsumer recycled content constitutes a minimum of 25 percent by weight.
 - 2) Metal Suspension System:
 - a) Provide products made from steel sheet with average recycled content such that the postconsumer recycled content plus one-half of the preconsumer recycled content is not less than 25 percent.
- C. Performance:
1. Fire-Test-Response Characteristics:
 - a. Surface-Burning Characteristics:
 - 1) Flame Spread Index:
 - a) Provide acoustical panels complying with the requirements for Fire Class B materials specified in ASTM E 1264 when tested in accordance with the method specified in ASTM E 84, which requires a Flame Spread Index of less than 75 on the face side.
 - 2) Smoke-Developed Index:
 - a) Provide acoustical panels having a Smoke-Developed Index of 450 or less when tested in accordance with the method specified in ASTM E 84.
 2. Seismic Performance:
 - a. Provide ceiling suspension systems complying with the seismic restraint requirements specified in ASTM E 580/E 580M, CISCA Guidelines for Seismic Restraint for Direct-hung Suspended Ceiling Assemblies (zones 3-4), and CISCA Recommendations for Direct-hung Acoustical tile and Lay-in Panel Ceilings (zones 0-2).
- D. Design Criteria:
1. Acoustical Panels:
 - a. Provide acoustical panels complying with the requirements specified in ASTM E 1264.
 2. Suspension Systems:
 - a. Structural Classification:
 - 1) Provide a double-web, steel suspension system classified as a Heavy-Duty System in accordance with the requirements specified in ASTM C 635.
 - b. Attachment Devices:



- 1) Unless otherwise indicated in the Contract Documents, size attachment devices for 5 times the design load indicated in "Table 1 - Direct Hung" in ASTM C 635.
- 2) Comply with the specified seismic performance requirements.
 - a) Provide seismic perimeter stabilizer bars, seismic struts, and seismic clips.
- c. Wire Hangers, Braces, and Ties:
 - 1) Select the wire diameter so its stress at 3 times the hanger design load indicated in "Table 1 - Direct Hung" in ASTM C 635 will be less than the yield stress of the wire, but do not provide wire having a diameters less than 0.106 inch (2.69mm).
3. Product Data:
 - a. Obtain Product Data for each type of acoustical ceiling panel and metal suspension system provided under this Section.
 - b. Submit the Product Data to the Program/Project Manager for approval.

E. Materials:

1. Acoustical Panel Ceilings:
 - a. Provide acoustical ceiling panels complying with the requirements for pattern designation CD (perforated with small holes and fissured) specified in ASTM E 126, and complying with the following requirements:
 - 1) Color/Light Reflectance Coefficient: White/LR 0.83.
 - 2) Noise Reduction Coefficient (NRC): 0.50.
 - 3) Edge Detail: Angled tegular lay-in.
 - 4) Size: ~~48~~ inches by 24 inches by 5/8 inch.
 - b. Manufacturers: **24 inches per RFI 1349**
 - 1) Armstrong World Industries, Inc., basis of design product Armstrong #703 and 704 Cortega, www.armstrong.com
 - 2) Armstrong #1774 Dune (for Stage 2), www.armstrong.com
 - 3) USG Corporation, www.usg.com. Product Radar #2320.
 - 4) Approved equal.
2. Metal Suspension System:
 - a. Main and Cross Runners:
 - 1) Provide pre-painted white main and cross runners that have been roll formed from cold-rolled steel sheet, and electrolytically zinc coated or hot-dip galvanized in accordance with the requirements for at least a G30 (Z90) coating designation specified in ASTM A 653/A 653M.
 - 2) Provide prefinished 15/16 inch (24mm) wide metal caps on the flanges.
 - 3) End Condition of Cross Runners:
 - a) Provide cross runners having either override (stepped) or butt-edge type ends.
 - b. Wire Hangers, Braces, and Ties:





- 1) Provide zinc-coated carbon-steel wire complying with the requirements specified for Class 1 zinc coating, soft temper wire in ASTM A 641/A 641M.
- c. Edge Moldings and Trim:
 - 1) Provide the type and profile of metal edge moldings and trim for edges and penetrations indicated in the Contract Documents; or, if the edge moldings and trim are not indicated, provide the manufacturer's standard moldings that comply with the seismic performance requirements
 - a) Provide metal edge moldings and trim formed from sheet metal of the same material, finish, and color used for the exposed flanges of the suspension system runners.
- d. Manufacturers:
 - 1) Armstrong World Industries, Inc., basis of design product Prelude XL 15/16 inch Exposed Tee System, Seismic Rx, www.armstrong.com
 - 2) USG Corporation, www.usg.com. Product Donn DX/DXL 15/16 inch Tee System.
 - 3) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine areas receiving the acoustical panel ceiling system for conditions that might adversely affect the installation.
 - a. Verify that building areas to receive the ceilings are free of construction dust and debris.
 - b. Verify that all work above the ceiling system has been satisfactorily completed prior to beginning to install the ceiling.
 2. Measure each ceiling area, and establish the layout of the acoustical panels to balance the border widths at opposite edges of each ceiling.
 - a. Avoid using less-than-half-width panels at borders.
- B. Evaluation and Assessment:
 1. Do not begin to install the ceiling until unsatisfactory conditions affecting the ceiling systems have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the acoustical panel ceilings.
- B. Demolition/Removal:



1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Provide acoustical panel ceilings complying with the requirements specified in ASTM C 636/C 636M, the seismic performance requirements specified, the manufacturer's installation instructions, and the Cisca Ceiling Systems Handbook.

1. Submit the acoustical panel ceiling manufacturer's written installation instructions to the Program/Project Manager for information.

- B. Suspension System:

1. Hangers:

- a. Suspend the ceiling hangers from the building's structural members, plumb and free from contact with insulation or other objects within the ceiling plenum.
- b. Splay hangers only where required to miss obstructions.
 - 1) Offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
- c. Where the width of ducts and other construction within the ceiling plenum produces hanger spacing that interferes with the location of hangers, provide trapezes or equivalent devices.
- d. When steel framing does not permit the installation of hanger wires at the spacing required, install carrying channels or other supplemental supports for attachment of the hanger wires.
- e. Do not attach hangers to steel deck tabs or to steel roof deck.

2. Edge Moldings and Trim:

- a. Provide edge moldings and trim of the type specified at the perimeter of the acoustical ceiling area, and where necessary to conceal edges of acoustical panels.
- b. Screw attach the moldings to the substrate at intervals not more than 16 inches (400mm) on center, and not more than 3 inches (75mm) from the ends.
- c. Miter the corners of the edge moldings and trim accurately, and connect the edge moldings and trim securely.

3. Suspension System Runners:

- a. Install the suspension system runners so they are square and securely interlocked with one another.
- b. Remove and replace dented, bent, or kinked members.

- C. Acoustical Panels:

1. Provide acoustical panels with undamaged edges, and fit them accurately into the suspension system runners and edge moldings.
2. Scribe and cut panels at the borders and penetrations to provide a neat, precise fit.



D. Tolerances:

1. Level the edge moldings and trim with the ceiling suspension system to within a tolerance of 1/8 inch in 12 feet (3.2mm in 3.6m).

3.04 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Take steps to ensure that installed acoustical panel ceilings are protected during subsequent construction activities.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	06/10/2011	N/A	All	First edition.
1	09/07/2018	N/A	2.01.E.1.b.2)	Clarify ceiling panel type for Stage 2.





SECTION 09548

TORSIONAL SPRING CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for torsional spring ceilings including suspension systems and accessories.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01454 - Mock-Up Requirements.
 - 4. Section 01732 - Cutting and Patching.
 - 5. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 2. NRC: Noise reduction coefficient.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - b. ASTM C 635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - c. ASTM C 636/C 636M – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - d. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - e. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the proper installation of inserts and related items with other trades.



- a. Provide layouts for inserts, clips, and other support items required to be installed by other trades.
- b. Furnish inserts, clips and related items to other trades in a timely manner to preclude construction delays.
2. Coordinate Work that penetrates planks.

B. Pre-Installation Meetings:

1. Pre-installation Conference:

- a. Prior to the start of installation of the torsional spring ceilings, schedule and conduct a pre-installation conference to review system requirements, Shop Drawings, and all coordination requirements.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Product Data:
 - 1) Torsion spring panels.
 - 2) Torsion spring ceiling suspension system.
 - 3) Acoustic backer.
 - 4) Access panels.
 - 5) Polywrapped acoustical infill Insulation
- b. Shop Drawings:
 - 1) Reflected ceiling plans.
 - 2) Layout of the suspension system and components.
 - 3) Details of the system assembly, and connections to building components.
- c. Samples:
 - 1) Torsional spring ceiling panel Samples.
 - 2) Color Samples.
 - 3) Samples of torsional spring ceiling suspension system components.
 - 4) Acoustical material Samples.
- d. Certificates:
 - 1) Certified data attesting that fire rated materials comply with fire-test-response characteristics specified.
- e. Qualification Statements:
 - 1) Torsional spring ceiling and suspension system installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Torsional spring ceiling manufacturer's printed installation instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Sustainable Design Closeout Documentation:
 - 1) Recycled Content: 10% (post-consumer + 1/2 pre-consumer), Submittal for torsional spring ceilings.
 - 2) Recycled Content: 20% (post-consumer + 1/2 pre-consumer), Submittal for torsional spring ceilings.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Furnish spare torsional spring ceiling units that match the products installed, packaged in the manufacturer's original packages for storage, and having a protective coverings and labels identifying the contents.
 - 2) Ceiling Units:
 - a) Furnish a spare quantity of full-size torsional spring ceiling units equal to one carton of each type of torsional spring ceiling unit installed.
 - b. Tools:
 - 1) Furnish access tools for the torsional spring ceilings.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Torsional Spring Ceiling Installer's Qualifications:
 - a. To install the torsional spring ceiling components and suspension system, retain the services of a firm that will employ installers having not less than 3 years of successful experience installing similar ceiling systems to that required under this Section on projects of similar size and scope as required by this Contract.
 - b. Submit the torsional spring ceiling and suspension system installer's qualifications to the Program/Project Manager for approval.

B. Sustainability Standards Certifications:

1. Recycled Content Submittals:
 - a. For torsional spring ceilings containing recycled content, submit Product Data, including documentation indicating percentages by weight of post-consumer and pre-consumer recycled content, certifying that these products qualify the Project to claim, Recycled Content: 10% (post-consumer + 1/2 pre-consumer).
 - b. For torsional spring ceilings containing recycled content in addition to the amount qualifying to submit Product Data, including



documentation indicating percentages by weight of post-consumer and pre-consumer recycled content, certifying that these products qualify the Project to claim 20% (post-consumer + 1/2 pre-consumer).

- c. Because these credits are based on costs, include a statement indicating the costs for each product having recycled content.

C. Site Samples:

1. Torsional Spring Ceiling Panel Samples:

- a. Submit Samples of each type and finish of torsional spring ceiling panel consisting of pieces of panel that are at least 8 inches (200mm) long to the Program/Project Manager for approval.

2. Color Samples:

- a. Submit Samples of the manufacturer's standard colors (finishes) to the Program/Project Manager for selection of the colors and finishes required for the Work of this section.

3. Samples of Torsional Spring Ceiling Suspension System Components:

- a. Submit Samples of the proposed suspension system components and moldings/trim to the Program/Project Manager for approval.

4. Acoustical Material Samples:

- a. Submit Samples of the proposed acoustical material to the Program/Project Manager for approval.

D. Mock-Ups:

- 1. Construct a mockup of the typical torsional spring ceiling system as indicated on the Contract Drawings and in accordance with the requirements specified in Section 01454, Mock-Up Requirements, to verify the selections made under the Sample submittals, for the selection of the metal panel perforation pattern by the Program/Project Manager, and to demonstrate the aesthetic effects and set the quality standards for fabrication and installation of the torsional spring ceilings:

- a. After the Samples have been approved, but prior to beginning to install the torsional spring ceilings, construct a mockup that is at least 12 feet by 20 feet in size where directed by the Program/Project Manager.
 - 1) Include all of the types of components required by the system and that match the system's components and use the same installation methods to construct the mock-ups that will be used to install the production Work.
- b. Include 1 bay having perforated metal panels with 0.28-inch diameter round perforations in a straight pattern producing a 1.5 percent open area.
- c. Include 1 bay having perforated metal panels with 0.059-inch diameter round perforations in a diagonal pattern producing an 18.4 percent open area.



- d. Include 1 bay having perforated metal panels with 0.063-inch diameter round perforations in a staggered pattern at 60-degrees producing a 25 percent open area. This applies for Stage 2 only.
 - e. Set the perforated panel options contiguous within the same suspension system as specified for the torsional spring ceiling system.
 2. Approval of the mockups does not constitute approval of deviations from the Contract Documents contained in the mockups unless the Program/Project Manager specifically approves such deviations in writing.
 - a. Approved mockups may become part of the completed Work if undisturbed at the time of Substantial Completion.

1.06 WARRANTY

- A. Manufacturer Warranty:
 1. Provide manufacturer's warranty against defects in workmanship, discoloration, or other defects considered undesirable by the Architect or Program/Project Manager.
 2. This warranty shall remain in effect for a minimum period of one (1) year from date of substantial completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver system components in the manufacturer's original unopened, clearly labeled packages.
- B. Storage and Handling Requirements:
 1. Store the torsional spring ceiling components in a fully enclosed dry space.
 2. Place the torsional spring ceiling components on skids, to prevent damage from moisture and other construction activities.
 3. Handle the torsional spring ceiling components so damage to surfaces and edges, and distortion and other physical damage, are prevented.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.08 SITE CONDITIONS

- A. Ambient Conditions:
 1. Prior to starting to install the torsional spring ceilings, allow the torsional spring ceiling system materials to reach the ambient room temperature and humidity intended to be maintained for occupancy in the space.

PART 2 PRODUCTS

2.01 METAL TORSION SPRING (SEGMENTED) PANEL CEILING SYSTEM

- A. Manufacturers:



1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain metal panel components from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.
 - 2) Obtain suspension system components from a single source from single manufacturer having the resources to provide products of consistent quality in appearance and physical properties without delaying the progress of the Work.
- B. Description:
1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with the requirements of the Phoenix Building Construction Code and Amendments (ICC International Building Code (IBC) as Amended by the City of Phoenix).
 2. Sustainability Requirements:
 - a. Sustainable Credits:
 - 1) Provide products for torsion spring ceilings that are capable of qualifying the Project for Recycled Content: 10% (post-consumer + 1/2 pre-consumer), Recycled Content: 20% (post-consumer + 1/2 pre-consumer), and Low-Emitting Materials: Adhesives & Sealants.
 - b. Recycled Content:
 - 1) Acoustical Panels:
 - a) Provide torsion spring ceiling panels with recycled content such that the postconsumer recycled content plus one-half of the pre-consumer recycled content constitutes a minimum of 25 percent by weight.
 - 2) Suspension System:
 - a) Provide suspension system products made from materials with average recycled content such that the postconsumer recycled content plus one-half of the pre-consumer recycled content is not less than 25 percent.
- C. Performance:
1. Provide the torsion spring ceiling manufacturer's standard system which when installed will comply with the following minimum requirements:



- a. Fire-Test-Response Performance:
 - 1) Surface-Burning Characteristics:
 - a) Provide torsion spring ceilings complying with the requirements for Fire Class A materials specified in ASTM E 1264, and complying with the following requirements when tested in accordance with the method specified in ASTM E 84:
 - (1) Flame Spread Index: 25 or less.
 - (2) Smoke-Developed Index: 50 or less.
 - b) Submit certified data attesting that fire rated materials comply with fire-test-response characteristics specified to the Program/Project Manager for information.
 - b. Structural Performance:
 - 1) Provide torsion spring ceiling and suspension system materials that comply with the requirements for the Heavy-Duty Systems classification specified in ASTM C 635.
 - 2) Submit certified test reports from an independent testing agency substantiating compliance of the torsion spring ceiling system with the structural requirements and other governing requirements.
 - 3) Install and certify system to comply with structural and wind load requirements of governing codes.
 - c. Acoustical Performance:
 - 1) Provide torsion spring ceiling panels having noise reduction coefficient (NRC) of 0.85 (Type E-400 Mount).
- D. Design Criteria:
 - 1. Provide a metal torsional spring (segmented) panel ceiling system designed for exposed interior and exterior installations, and to form closed butt joints between panels.
 - 2. Accessibility:
 - a. Provide ceiling panels having a minimum of 4 torsion springs that support each panel as it is lowered downward to furnish access to the area above the panel.
 - b. Provide the manufacturer's standard hinged style access panels at the locations indicated on the Contract Drawings.
 - 3. Product Data:
 - a. Obtain the manufacturer's Product Data for the torsion spring ceiling system.
 - b. Submit the Product Data of the torsion spring ceiling system to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings of the torsion spring ceiling system that include the following items:
 - 1) Reflected ceiling plans that indicate the metal panel ceiling layout, ceiling mounted items, and penetration locations.
 - 2) Layout of the suspension system and components.



- 3) Details of the system assembly, and connections to building components.
 - b. Submit the Shop Drawings of the torsion spring ceiling system to the Program/Project Manager for approval.
- E. Materials:
1. Metal Torsion Spring (Segmented) Panel Ceiling System:
 - a. Torsion Spring Panels:
 - 1) Panel Type:
 - a) Provide 0.032-inch (0.8mm) thick aluminum torsion spring ceiling panels having a square edge profile with 2 die formed side legs, and 2 die formed end legs that have been punched to receive the torsion springs.
 - b) Provide 0.63-inch thick aluminum torsion spring ceiling panels having a square edge profile with 2 die formed side legs, and 2 die formed end legs that have been punched to receive the torsion springs, for exterior and oversized applications.
 - c) On each end of each panel, provide 2 torsion springs that securely engage into tee grid main runners that have been factory-punched to receive the springs.
 - 2) Width/Length:
 - a) Provide 16-inch (406mm) wide by 60-inch (1524mm) long ceiling panels.
 - b) Provide 48-inch wide by 120-inch long ceiling panels, at Stage 2.
 - c) Provide 48-inch wide by 120-inch long exterior ceiling panels, at Stage 2.
 - 3) Perforations:
 - a) Provide metal planks having 1/4 inch (6.4mm) nominal solid border, and a perforation pattern to be determined by the Program/Project Manager.
 - b) Provide metal planks having 1/4 inch (6.4mm) nominal solid border, and perforation pattern, Hunter Douglas pattern #127, or approved equal, for Stage 2 only.
 - 4) Color and Finish:
 - a) Provide a torsion spring ceiling panel system having a white baked-on polyester enamel finish.
 - b) Provide an exterior torsion spring ceiling panel system having a one-color wood veneer baked-on polyester enamel finish.
 - b. Torsion Spring Ceiling Suspension System:
 - 1) Provide a concealed suspension system that is segmented so the ceiling supported can be curved.
 - 2) Main Runners:
 - a) Provide 1-1/2 inch (38mm) deep by 12'-0" long, inverted T-section main runners having factory-punched flanges designed to receive the torsion spring assembly.



- b) Provide main tee on center spacing that matches the panel length.
 - c) Provide main tee that have been factory-segmented to have the radius indicated on the Contract Drawings.
 - 3) Cross Runners:
 - a) Provide 1-1/2 inch (38mm) deep, inverted T-section cross runners designed to interlock at a designated spacing into the web of the main tee sections.
 - b) Provide cross tee having a length matching the panel length.
 - c) Space cross tees no more than 48 inches apart on center.
 - 4) Hanger wire:
 - a) Provide 12 gage, pre-stretched galvanized steel hanger wire.
 - b) Space the hanger wires no more than 48 inches apart on center.
 - c. Acoustic Fabric:
 - 1) Do not provide non-woven acoustic fabric backer between the perforated metal pans and acoustical fiberglass infill for Stage 2 interior ceilings only.
 - d. Acoustic Backer:
 - 1) Provide 2-inch thick 3-pound fiberglass infill panels sized to completely fill the ceiling panel.
 - 2) Provide 1-inch thick 1.5 pcf polywrapped fiberglass infill panels sized to completely fill the ceiling panel. Provide at Stage 2 interior ceilings only.
 - e. Access Panels:
 - 1) Provide the manufacturer's standard hinged style access panels.
 - f. Manufacturers:
 - 1) Hunter Douglas Architectural Products, Inc., <http://www.hunterdouglascontract.com>.
 - 2) Armstrong World Industries, Inc., <http://www.armstrong.com>.
 - 3) USG Corporation. www.usgdesignstudio.com
 - 4) Approved equal.
2. Perimeter Trim:
- a. Provide perimeter trim for the segmented torsion spring panel ceiling system fabricated from extruded aluminum complying with the requirements for aluminum Alloy 6063 specified in ASTM B 221, and factory-finished with a baked-on polyester paint having a color matching the panel finish.
 - 1) To join perimeter ceiling panels flush with adjacent construction, provide channel trim having a height of 4 inches and a 3/4-inch flange.
 - 2) Provide other trim and corner assemblies that have been fabricated in lengths of 16 feet.



- b. Provide integral splice clips, corner clips, and suspension clips for attaching the perimeter trim to the ceiling suspension system as required.
 - 1) Provide straight splice clips having set screws.
 - 2) Provide corner brackets having set screws.
 - 3) Provide T-bar connector clips.
 - 4) Provide factory-assembled corners
- c. Manufacturers:
 - 1) Hunter Douglas Architectural Products, Edgeline Trim Systems, <http://www.hunterdouglascontract.com>.
 - 2) Armstrong World Industries, Inc., <http://www.armstrong.com>.
 - 3) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine areas receiving the torsional spring ceiling system for conditions that might adversely affect the installation.
 - a. Verify that all work above the ceiling system has been satisfactorily completed prior to beginning to install the ceiling.
 - 2. Measure each ceiling area and establish the layout of the torsional spring ceiling to balance the borders and minimize out-of-square conditions.
- B. Evaluation and Assessment:
 - 1. Do not begin to install the ceiling until unsatisfactory conditions affecting the ceiling systems have been corrected.
 - 2. Do not begin installing the torsional spring system until the spaces are enclosed and weather tight, and all wet work and overhead work have been completed.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the torsional spring ceilings.
- B. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install the torsion spring panel system in accordance with the requirements specified in ASTM C 636/C 636M, the torsional spring ceiling manufacturer's installation instructions, approved torsional spring ceiling submittals, and in accordance with local building codes and practices.



1. Submit the torsional spring ceiling manufacturer's printed installation instructions to the Program/Project Manager for approval.
- B. Suspension System:
 1. Hangers:
 - a. Suspend the ceiling hangers from the building's structural members, plumb and free from contact with insulation or other objects within the ceiling plenum.
 - b. Splay hangers only where required to miss obstructions.
 - 1) Offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - c. Where the width of ducts and other construction within the ceiling plenum produces hanger spacing that interferes with the location of hangers, provide trapezes or equivalent devices.
 - d. When steel framing does not permit the installation of hanger wires at the spacing required, install carrying channels or other supplemental supports for attachment of the hanger wires.
 - e. Do not attach hangers to steel deck tabs or to steel roof deck.
 2. Edge Moldings and Trim:
 - a. Provide edge moldings and trim of the type specified at the perimeter of the torsional spring ceiling area, and where necessary to conceal edges of torsional spring ceiling panels.
 - b. Screw-attach the moldings to the substrate at intervals not more than 16 inches (400mm) on center, and not more than 3 inches (75mm) from the ends.
 - c. Miter the corners of the edge moldings, trim accurately, and connect the edge moldings and trim securely.
 3. Suspension System Runners:
 - a. Install the suspension system runners so they are square and securely interlocked with one another.
 - b. Assemble the tee grid suspension system by connecting the cross runners to suspended main runners to form a mounting grid for the ceiling panels.
 - c. Main runners:
 - 1) Install the main runners at the spacing matching the panel length.
 - 2) Suspend the main runners using hanger wires spaced on maximum 48 inches (1219mm) centers, and within 12 inches (305mm) of walls.
 - d. Remove and replace dented, bent, or kinked members.
- C. Torsion Spring Panels
 1. Install the torsion spring ceiling panels by lifting the panel and inserting the free ends of torsion springs into the factory-punched slots in the flanges of the T-shaped, segmented main runners.



2. After the free ends of all torsion springs on a single panel are in the main tee slots, raise the panel up against the bottom flange of the main tee until the springs expand, securing the panels firmly in place.

D. Interface with Other Work:

1. Coordinate and provide accommodation for the fire suppression system components; heating, ventilating, and air-conditioning (HVAC) components; and lighting fixtures in the area of the torsional spring ceiling system installation.

3.04 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Take steps to ensure that installed torsional spring ceilings are protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	09/07/2018	N/A	1.04.A.1.a.5), 1.05.D.1.d, 2.01.C.1.c, 2.01.E.1.a.1).b), 2.01.E.1.a.2).b) & c), 2.01.E.1.3).b). 2.01E.1.a.4).b), 2.01.E.1.c & d	Clarify ceiling panel types, sizes and acoustical infill for Stage 2.



SECTION 09653

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for resilient wall base.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. VCT: Vinyl Composition Tile.
 - 2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - ASTM E 648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - ASTM E 662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - ASTM F 1861 – Standard Specification for Resilient Wall Base.
 - 2. City of Phoenix (COP):
 - Phoenix Building Construction Code and Amendments.
 - 3. South Coast Air Quality Management District (SCAQMD):
 - SCAQMD Rule #1168 – Adhesive and Sealant Applications.
 - 4. U. S. Government:
 - Environmental Protection Agency (EPA):
 - a. 40 CFR 59 National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - 5. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate resilient product installation with other construction to minimize the possibility of damage and soiling during the remainder of the construction period.
- B. Sequencing:
 - 1. Install resilient products after other finishing operations, including painting, have been completed.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - a. Rubber wall base.
 - b. Vinyl wall base.
 - c. Trowelable leveling and patching compounds.
 - d. Adhesives.
 - b. Samples:
 - e. Verification Samples.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - a. Resilient wall base manufacturer's written installation instructions.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1. Submit product data highlighting the VOC content for any field applied adhesive or sealant used.
 - 2. Flooring Systems
 - 1. Submit Floorscore certificates for each resilient base or flooring product provided.
- C. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - a. Furnish the following extra materials that match the products installed, are packaged with protective covering for storage, and



are identified with labels describing contents, and deliver them to the Owner:

- a) Not less than 10 linear feet for each 500 linear feet or fraction thereof, of each different type, color, pattern, and size of resilient product installed.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Sustainability Standards Certifications:
 1. Low-Emitting Materials Submittal:
 - a. For the adhesives used for the wall base and accessories, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, certifying that these products comply with SCAQMD Rule #1168.
- C. Site Samples:
 1. Verification Samples:
 - a. Provide verification Samples for each product color and pattern specified of the manufacturer's standard sizes, but not less than 12 inches long.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver products to Site in the manufacturer's original, unopened cartons and containers, each bearing the names of the product and manufacturer, Project and Contract identification, and shipping and handling instructions.
- B. Storage and Handling Requirements:
 1. Store products in dry spaces protected from the weather, with ambient temperatures maintained between 50 degrees Fahrenheit and 90 degrees Fahrenheit.
 2. Move products into spaces where they will be installed at least 48 hours before installation, unless a longer conditioning period is recommended by manufacturer in writing.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. In the spaces to receive resilient products, maintain a temperature of not less than 70 degrees Fahrenheit or more than 95 deg F for at least 48 hours before installation, during installation, and for at least 48 hours after



installation, unless manufacturer's written recommendations specify longer time periods.

2. Following installation of the resilient products, maintain a temperature of not less than 55 degrees Fahrenheit or more than 95 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer List:

1. Roppe, www.roppe.com.
2. Johnsonite, www.johnsonite.com.
3. Burke, www.endura-flooring.com.

B. Product Options:

1. Subject to compliance with the Contract requirements, provide one of the products specified for each designation.
 - (a) Color:
 - (i) Provide colors to be selected by the Program/Project Manager from the manufacturer's standard colors.
 - (b) Source Limitations:
 - (i) Obtain each type and color of product specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
 - (c) Product Data
 - (i) Submit Product Data for each type of product specified herein.

2.02 SUSTAINABILITY REQUIREMENTS:

A. Volatile Organic Compounds (VOC) Content of Interior Sealants:

1. Provide sealants and sealant primers for the interior architectural woodwork of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule #1168:
 - (a) Vinyl Composition Tile (VCT) and Asphalt Tile Adhesives: Not more than 50 grams per Liter less water
 - (b) Rubber Floor Adhesives: Not more than 60 grams per Liter less water.

B. All Resilient flooring and base products must be certified under Floorscore.

2.03 PERFORMANCE

A. Fire-Test-Response Characteristics:

1. Provide products having the following fire-test-response characteristics determined by a testing and inspecting agency acceptable to Authorities



Having Jurisdiction testing identical products in accordance with the test method specified:

- (a) Critical Radiant Flux: 0.45 Watts per square centimeter or greater when tested in accordance with the requirements of ASTM E 648.
- (b) Smoke Density: Specific optical density of 450 or less when tested in accordance with the requirements of ASTM E 662

2.04 MATERIALS:

A. Resilient Wall Base:

1. Rubber Wall Base:

- (a) Where the "RB" designation is indicated on the Contract Drawings, provide rubber wall base.
- (b) Provide either Type TS, rubber, vulcanized thermoset, or TP, rubber, thermoplastic, resilient wall base as specified in ASTM F 1861 having a cove with a top-set toe.
- (c) Minimum Nominal Thickness: 1/8 inch.
- (d) Height: 4 inches except where 6 inches is indicated on the Contract Drawings.
- (e) Lengths: Coils of the manufacturer's standard lengths, but not less than 100 feet.
- (f) Exterior Corners: Premolded.
- (g) Interior Corners: Mitered.

2. Vinyl Wall Base:

- (a) Provide Type TV, vinyl, thermoplastic, resilient wall base as specified in ASTM F 1861, and having a cove base.
- (b) Height: 4 inches except where 6 inches is indicated on the Contract Drawings.
- (c) Lengths: Coils of the manufacturer's standard lengths, but not less than 100 feet.
- (d) Exterior Corners: Premolded.
- (e) Interior Corners: Mitered.

2.05 ACCESSORIES

A. Trowelable Leveling and Patching Compounds:

- 1. Provide a latex-modified, Portland-cement-based formulation supplied or approved by the resilient product manufacturer for the applications indicated on the Contract Drawings.

B. Adhesives:

- 1. Provide water-resistant type adhesives recommended by the resilient product manufacturer to suit the resilient products and substrate conditions indicated on the Contract Drawings, and meeting the specified requirements for volatile organic compounds (VOC) content.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine substrates, areas, and conditions where resilient products will be installed for compliance with the manufacturer's requirements, including those for maximum moisture content.
 - 2. Verify that substrates and conditions are satisfactory for installing resilient products, and comply with the requirements specified.
- B. Evaluation and Assessment:
 - 1. Do not install resilient products until they are at the same temperature as the space where they are to be installed.
 - 2. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Comply with resilient product manufacturer's written installation instructions for preparing substrates indicated to receive resilient products.
 - 2. To fill cracks, holes, and depressions in substrates, provide trowelable leveling and patching compounds applied according to the compound manufacturer's written instructions.
 - 3. Immediately before installing resilient products, broom and vacuum clean the substrates to be covered.
 - a. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.
 - b. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Demolition/Removal:
 - 1. Using mechanical methods recommended by the adhesive manufacturer, remove coatings, including curing compounds and other substances that are incompatible with the adhesives, and that contain soap, wax, oil, or silicone.
 - a. Do not use solvents.

3.03 INSTALLATION

- A. Install resilient wall base and accessories according to the manufacturer's written installation instructions.
 - 1. Submit the resilient wall base manufacturer's written installation instructions to the Program/Project Manager for information.



- B. Apply resilient wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
 - 1. Install wall base in lengths as long as practicable without gaps at seams, and with tops of adjacent pieces aligned.
 - 2. Adhere the wall base tightly to the substrate throughout the length of each piece, with the base in continuous contact with horizontal and vertical substrates.
 - 3. Do not stretch the base during installation.
 - 4. On masonry surfaces or other similar irregular substrates, fill voids along the top edge of the resilient wall base with the manufacturer's recommended adhesive filler material.
 - 5. Install premolded outside corners before installing straight pieces.
- C. Place resilient products so they are butted to adjacent materials, and bond the resilient products to substrates with adhesive.
 - 1. Install reducer strips at the edges of flooring that would otherwise be exposed.

3.04 CLEANING

- A. Immediately after installing resilient products, perform the following tasks:
 - 1. Remove visible adhesive and other surface blemishes from the resilient wall base using a cleaner recommended by the resilient product manufacturer.
 - 2. Thoroughly sweep or vacuum the floor and base surfaces.
 - 3. Do not wash resilient products until after the time period recommended by the resilient product manufacturer.
 - 4. Damp-mop or sponge the resilient products to remove marks and soil.
- B. Clean resilient products no more than 4 days before inspections intended to establish the date of Substantial Completion in each area of the Site.
 - 1. Clean products according to manufacturer's written recommendations.

3.05 PROTECTION

- A. For resilient products installed on traffic surfaces, close the spaces to traffic during installation, and for the period after installation recommended by manufacturer in writing.
- B. Protect resilient products against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period.
- C. Use protection methods indicated or recommended by the resilient product manufacturer in writing.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.C.5, 1.04.B.2, 1.05.B.1	Add requirements for ENVISION Sustainability Rating System



SECTION 09658

RESILIENT TILE FLOORING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for vinyl composition floor tile.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. VCT: Vinyl Composition Tile.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
 - 3. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM E 648 – Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - b. ASTM F 710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - c. ASTM F 1066 - Standard Specification for Vinyl Composition Floor Tile.
 - d. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. National Fire Protection Association (NFPA):



- a. NFPA 253 – Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
- 4. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule #1168 – Adhesive and Sealant Applications.
- 5. U. S. Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 6. United States Green Building Council (USGBC):
 - a. LEED® for New Construction and Major Renovations, Version 2009.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Install floor tile after other finishing operations, including painting, have been completed.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Vinyl composition floor tile.
 - 2) Trowelable leveling and patching compounds.
 - 3) Adhesives.
 - 4) Floor polish.
 - b. Shop Drawings:
 - 1) Shop Drawings for each type of resilient floor tile.
 - c. Samples:
 - 1) Floor tile Samples.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Resilient tile flooring manufacturer's written installation instructions.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Adhesives and Sealants
 - 1) Submit product data highlighting the VOC content for any field applied adhesive or sealant used.
 - b. Flooring Systems



- 1) Submit Floorscore certificates for each resilient base or flooring product provided.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Resilient floor tile maintenance data.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Site Samples:

1. Floor Tile Samples:
 - a. Provide full-size Samples of each color and pattern of the floor tile specified and proposed for the Work of this Contract.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver products to Site in the manufacturer's original, unopened cartons and containers, each bearing the names of the product and manufacturer, Project and Contract identification, and shipping and handling instructions.

B. Storage and Handling Requirements:

1. Store products in dry spaces protected from the weather, with ambient temperatures maintained within the range recommended by manufacturer.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Maintain ambient temperatures within the range recommended by manufacturer in spaces to receive floor tile.
2. Maintain ambient temperatures within the range recommended by the resilient tile flooring manufacturer until Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer List:

1. Armstrong World Industries, Inc., Premium Excelon Tile,
www.armstrong.com.



B. Product Options:

1. Subject to compliance with the Contract requirements, provide the products specified from available sources.
 - a. Color:
 - 1) Provide materials having the colors and patterns selected by the Program/Project Manager from the full range of available industry colors.
 - b. Product Data:
 - 1) Submit Product Data from the manufacturers for each type of product specified and provided under this Section.

2.02 DESCRIPTION:

A. Regulatory Requirements:

1. Volatile Organic Compounds (VOC) Content of Adhesives:
 - a. Provide adhesives for the resilient tile flooring of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - 1) Vinyl Composition Tile (VCT) and Asphalt Tile Adhesives: Not more than 50 grams per Liter.
 - 2) Rubber Floor Adhesives: Not more than 60 grams per Liter.

B. Sustainability Requirements:

1. All Resilient flooring and base products must be certified under Floorscore.
2. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - a. Provide adhesives, sealants, and sealant primers for the resilient tile flooring of this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule #1168:
 - 1) Vinyl composition tile and asphalt adhesives: Not more than 60 grams per Liter less water.

2.03 PERFORMANCE

A. Fire-Test-Response Characteristics:

1. Provide products having the following fire-test-response characteristics determined by a testing and inspecting agency acceptable to Authorities Having Jurisdiction testing identical products in accordance with the test method specified:
 - a. Critical Radiant Flux Classification: Class I, 0.45 Watts per square centimeter or greater when tested in accordance with the requirements of ASTM E 648 or NFPA 253.



2.04 DESIGN CRITERIA

- A. Shop Drawings:
 - 1. Submit Shop Drawings for each type of resilient floor tile.
 - a. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

2.05 MATERIALS

- A. Vinyl Composition Floor Tile (VCT-1):
 - 1. Provide Class 2 solid vinyl composition floor tile complying with the requirements specified in ASTM F 1066.
 - 2. Wearing Surface: Smooth.
 - 3. Thickness: 0.125 inch (3.2mm).
 - 4. Size: 12 inches by 12 inches (305mm by 305mm).

2.06 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds:
 - 1. Provide a latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation supplied or approved by the resilient product manufacturer for the applications indicated on the Contract Drawings.
- B. Adhesives:
 - 1. Provide water-resistant type adhesives recommended by the resilient product manufacturer to suit the floor tile and substrate conditions indicated on the Contract Drawings, and meeting the specified requirements for volatile organic compounds (VOC) content.
- C. Floor Polish:
 - 1. Provide protective liquid floor polish products as recommended by resilient floor tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the spaces where resilient tile flooring is to be installed are at the required ambient temperatures, and otherwise ready to receive resilient tile flooring.
- B. Pre-Installation Testing:
 - 1. Alkalinity and Adhesion Testing:
 - a. Perform alkalinity and adhesion tests recommended by the floor covering manufacturer.
 - 2. Moisture Testing:



- a. Perform moisture tests recommended by the floor covering manufacturer.
 - b. Perform the anhydrous calcium chloride test, as specified in ASTM F 1869.
- C. Evaluation and Assessment:
 - 1. Proceed with installation only after substrates pass the alkalinity, adhesion, and moisture testing.
 - a. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [3] pounds of water per 1000 square feet ([1.36] kg of water per 92.9 square meters) in 24 hours.
 - 2. Do not install floor tiles until they are same temperature as the space where they are to be installed.
 - a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Prepare substrates according to the resilient tile flooring manufacturer's written instructions to ensure adhesion of the resilient products.
 - a. Concrete Substrates:
 - 1) Prepare the substrates according to the requirements specified in ASTM F 710.
 - 2) Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. To fill cracks, holes, and depressions in substrates and remove bumps and ridges to produce a uniform and smooth substrate, provide trowelable leveling and patching compounds applied according to the compound manufacturer's written instructions.
 - 3. Immediately before installing resilient products, sweep and vacuum clean the substrates to be covered.
 - a. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.
 - b. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Demolition/Removal:
 - 1. Using mechanical methods recommended by resilient tile flooring manufacturer, remove substrate coatings and other substances that are incompatible with the adhesives, and that contain soap, wax, oil, or silicone.
 - a. Do not use solvents.



3.03 INSTALLATION

- A. Install resilient tile flooring according to the manufacturer's written installation instructions.
 - 1. Submit the resilient tile flooring manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Layout:
 - 1. Lay out floor tiles from center marks established from the principal walls, discounting minor offsets, so the tiles at opposite edges of the room are of equal width.
 - 2. Make adjustments as necessary to avoid using cut widths that equal less than one-half tile at the perimeter.
 - 3. Lay tiles square with room axis.
- C. Color and Pattern Matching:
 - 1. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as they were manufactured and packaged, if numbered in sequence.
 - 2. Discard broken, cracked, chipped, or deformed tiles.
 - 3. Lay tiles in a basket-weave pattern with the grain direction alternating in adjacent tiles.
- D. Fitting and Installing Tile:
 - 1. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, and door frames.
 - 2. Extend floor tiles into toe spaces, door reveals, closets, and similar openings.
 - 3. Extend floor tiles to the center of door openings.
 - 4. Adhere floor tile to the flooring substrates using a full spread of adhesive applied to the substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- E. Recording In-Place Markers, Holes, and Openings:
 - 1. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating the reference markers on the floor tiles as marked on substrates.
 - 2. Use chalk or other nonpermanent, non-staining marking devices to repeat the markers.

3.04 CLEANING

- A. Clean and protect the resilient floor tile in accordance with the manufacturer's written instructions.



3.05 PROTECTION

- A. Close spaces to traffic during floor tile installation.
- B. Close spaces to traffic for 48 hours after floor tile installation.
- C. Floor Polish:
 - 1. Remove soil, visible adhesives, and surface blemishes from the floor tile surfaces before applying liquid floor polish.
 - 2. Apply 3 coats of floor polish.
- D. Cover installed floor tile until Substantial Completion.

3.06 MAINTENANCE

- A. Maintenance Data:
 - 1. Submit maintenance data for the resilient floor tile provided.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	08/01/2018	N/A	All	First edition.



SECTION 09912

PAINTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the surface preparation and field painting of the following:
 - a. Exposed exterior items and surfaces.
 - b. Exposed interior items and surfaces.
 - 2. The surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AESS: Architecturally Exposed Structural Steel.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. FM: Factory Mutual FM.
 - 4. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 5. UL: Underwriters Laboratories.
- B. Definitions:
 - 1. Standard coating terms defined in ASTM D 16 apply to the Work of this Section.
 - 2. Benchmark Sample: A sample that serves as a standard by which other Work may be measured or judged.



3. Exposed Surfaces: Areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM A 16 – Terminology for Paint, Related Coatings, Materials, and Applications.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. Green Seal, Inc. (GS):
 - a. GC-03 - Green Seal™ Environmental Criteria for Anti-Corrosive Paints.
 - b. GS-11 – Green Seal™ Environmental Standard for Paints and Coatings.
4. Painting and Decorating Contractors of America (PDCA):
 - a. PDCA P1 – Touch-Up Painting and Damage Repair: Financial Responsibility.
 - b. PDCA P5 – Benchmark Sample Procedures for Paint and Other Decorative Coating Systems.
5. Painting and Decorating Contractors of America (PDCA), Arizona Council:
 - a. AZP-P07-89 - Technical Paper - Arizona Council.
6. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1113 – Architectural Coatings.
7. SSPC: The Society for Protective Coatings (SSPC):
 - a. SSPC Painting Manual, Volume 1 – Good Painting Practice.
 - b. SSPC Painting Manual, Volume 2 – Systems and Specifications.
8. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
9. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review other Specification Sections in which primers or other coatings are provided to ensure compatibility of the total systems for various substrates.
 - a. Upon request, furnish information on the characteristics of specified finish materials to ensure compatible primers.



- b. Notify the Program/Project Manager of problems anticipated using the materials specified.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Product Data:
 - 1) Exterior latex block filler.
 - 2) Exterior acrylic masonry primer/sealer.
 - 3) Exterior acrylic semigloss enamel.
 - 4) Interior pigmented latex sealer.
 - 5) Interior acrylic semi-gloss enamel.
 - 6) Interior acrylic enamel undercoater.
 - 7) Interior/exterior acrylic gloss paint.
 - 8) Interior acrylic multi-purpose primer.
- b. Samples:
 - 1) Verification Samples.
- c. Certificates:
 - 1) Paint Manufacturer's Certification.
- d. Delegated Design Submittals:
 - 1) Paint Material List.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Manufacturer's Instructions:
 - 1) Manufacturer's Information.
- b. Manufacturer's Reports:
 - 1) Manufacturer's color charts.
 - 2) Manufacturer's material data and certificates of performance for proposed substitutions.
 - 3) Manufacturer's or distributor's numbered invoices.
2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coating within the buildings weather barrier.

C. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:



- 1) Furnish an additional 5 gallons of paint, as appropriate, of each type and color applied to the Owner.
 - a) Furnish paint from the same production run as materials applied.
 - b) Package this paint in unopened, factory-sealed containers suitable for storage, and identify the containers with labels describing the contents of each.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Comply with the Occupational Safety and Health Administration (OSHA) regulations stipulated in 29 CFR 1910 and 29 CFR 1926.
 2. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Certifications:
 1. Paint Manufacturer's Certification:
 - a. Submit a Paint Manufacturer's Certification from the manufacturer certifying that the products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) as specified herein.
- C. Site Samples:
 1. Benchmark Finish Sample:
 - a. Provide a full-coat benchmark finish sample of each type of coating and substrate required for the Contract to the Program/Project Manager for approval.
 - 1) Comply with the procedures specified in PDCA P5.
 - 2) Duplicate finish of approved prepared samples.
 - b. The Program/Project Manager will select one room or surface to represent the surfaces and conditions for each type of coating and substrate to be painted.
 - c. Apply the coatings in this room or surface in accordance with the schedule or as specified.
 - d. After the finishes are accepted, this room or surface will be used for evaluation of coating systems of a similar nature.
 1. Verification Samples:
 - a. Submit Verification Samples of each color and material to be applied, on representative Samples of the actual substrate with a texture to simulate actual conditions to the Program/Project Manager for approval.
 - 1) Provide Samples of each color defining each separate coat, including block fillers and primers.
 - 2) Use representative colors when preparing Samples for review.



- 3) Resubmit Verification Samples until the required sheen, color, and texture are achieved.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials to the Site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
 2. Paint material containers not displaying manufacturer's product identification are unacceptable.
- B. Storage and Handling Requirements:
 1. Store paint not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees Fahrenheit.
 2. Store opened containers of high-performance coating in a clean condition, free of foreign materials and residue.
 3. Keep the storage area neat and orderly.
 - a. Remove oily rags and waste daily.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Apply water-based paints only when temperature of surfaces to be painted and the surrounding air temperatures are between 50 and 90 degrees Fahrenheit (10 and 32 degrees Celsius).
 2. Apply solvent-thinned paints only when temperature of surfaces to be painted and the surrounding air temperatures are between 45 and 95 degrees Fahrenheit (7.2 and 35 degrees Celsius).
 3. Do not apply paint under the following conditions:
 - a. When it is snowing, raining, foggy, or misty where the coating operation is occurring.
 - b. When the relative humidity exceeds 85 percent.
 - c. When temperatures are less than 5 degrees Fahrenheit (3 degrees Celsius) above the dew point.
 - d. When the surfaces are damp or wet.
 4. Painting may continue during inclement weather if the surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during the application and drying periods.
 5. Protect materials from freezing.

PART 2 PRODUCTS

2.01 PAINT SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Dunn-Edwards Corporation, <https://www.dunnedwards.com/>.



- b. The Sherwin-Williams Company, www.sherwin-williams.com.
 - c. International Protective Coatings; International Paint, Inc. distributed by Dunn-Edwards Paints, www.international-pc.com.
 - d. Carboline Company, an RPM Company, <http://www.carboline.com>.
 - 2. Substitution Limitations:
 - a. This Specification is written naming products manufactured or distributed by Dunn-Edwards Corporation.
 - 1) The products specified establish standards for kind, quality, sheen, and function desired for this Contract.
 - 2) The use of a manufacturer's proprietary product names to designate colors or materials is not intended to imply that the products named are required to be used to the exclusion of equivalent products of other manufacturers.
 - b. Submit the manufacturer's material data and certificates of performance for proposed substitutions to the Program/Project Manager for approval.
 - 3. Product Options:
 - a. Subject to compliance with the Contract requirements, provide one of the products indicated in the paint schedules.
 - b. Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
- B. Sustainability Requirements:
 - 1. Volatile Organic Compounds (VOC) Content of Field-Applied Interior Paints and Coatings:
 - a. Provide paint products having volatile organic compound content, exclusive of colorants added to a tint base, not greater than the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - 1) Flat, Non-Flat and High-gloss Paints and Coatings: Not more than 50 grams per Liter.
 - 2) Primers, Sealer and Undercoats: Not more than 100 grams per Liter.
 - 3) Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: Not more than 100 grams per Liter.
 - 4) Floor Coatings: Not more than 50 grams per Liter.
 - b. Refer to Section 01360 - Sustainable Design Requirements for complete list of VOC limits for this project.
- C. Design Criteria:
 - 1. Material Compatibility:
 - a. Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated in the Contract Documents under the conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.



2. Material Quality:
 - a. Provide the best quality, top of the line paint material of the various coating types specified.
3. Colors:
 - a. Provide colors as selected by the Program/Project Manager from the manufacturer's full range.
 - b. Submit the manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated herein to the Program/Project Manager for information.
4. Minimum Coating Thickness:
 - a. Apply paint materials no thinner than the manufacturer recommended spreading rate.
 - b. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
5. Product Data:
 - a. Submit Product Data for each paint system specified, including block fillers and primers, to the Program/Project Manager for approval.
 - b. Paint Material List:
 - 1) Submit an inclusive Paint Material List of the required coating materials to the Program/Project Manager for approval.
 - a) Indicate each material, and cross-reference the specific coating, finish system, and application.
 - b) Identify each material by the manufacturer's catalog number and general classification.
 - c. Manufacturer's Information:
 - 1) Submit the manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use to the Program/Project Manager for information.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the Applicator present, examine the substrates and conditions under which the paint will be applied for compliance with coating application requirements.
- B. Evaluation and Assessment:
 1. Do not apply paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable paint film.
 2. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive paint are thoroughly dry.
 - a. The start of painting will be construed as the applicator's acceptance of the surfaces within that particular area.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect the Work of other trades, whether being coated or not, against damage from painting.
 - 2. Take the necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying the coatings.
- B. Surface Preparation:
 - 1. For each particular substrate condition, clean and prepare the surfaces to be painted according to the manufacturer's written instructions and as specified herein.
 - a. Provide barrier coats over incompatible primers, or remove the incompatible primers and re-prime the substrate.
 - 2. Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the coatings.
 - a. Remove oil and grease before cleaning.
 - b. Schedule the cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.
 - 3. Cementitious Materials:
 - a. Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted.
 - 1) Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents.
 - 2) Roughen the surfaces as required to remove glaze.
 - 3) If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a) Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
 - 4) Determine the alkalinity and moisture content of the surfaces by performing appropriate tests.
 - a) If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before applying the paint.
 - b) Do not paint surfaces where the moisture content exceeds that permitted in the manufacturer's written instructions.
 - 4. Ferrous-Metal Substrates:
 - a. Clean ungalvanized ferrous-metal surfaces that have not been shop coated.
 - 1) Remove oil, grease, dirt, loose mill scale, and other foreign substances.
 - b. Use solvent or mechanical cleaning methods that comply with recommendations provided in the SSPC Steel Structures Painting Manual.



- 1) Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
- 2) Touch up bare areas and shop-applied prime coats that have been damaged.
 - a) Wire-brush, clean with solvents recommended by paint manufacturer, and touch up these areas with the same primer as the shop coat.
5. Galvanized Surfaces:
 - a. Clean galvanized surfaces with nonpetroleum-based solvents so the surface is free of oil and surface contaminants.
 - b. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

C. Demolition/Removal:

1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted.
 - a. If removal of these items is impractical or impossible because of the size or weight of the items, provide surface-applied protection before initiating surface preparation and coating.

3.03 SURFACES AND SUBSTRATES

A. Exposed Surfaces:

1. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural.
2. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors.
3. If the schedules do not indicate color or finish, the Program/Project Manager will select the color or finish from the standard colors and finishes available.
 - a. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

B. Concealed Surfaces:

1. Do not paint concealed surfaces.
2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Furred areas.
 - b. Ceiling plenums.
 - c. Utility tunnels.
 - d. Pipe spaces.
 - e. Duct shafts.



- C. Finished Metal Surfaces and Prefinished Items:
 - 1. Do not paint finished metal surfaces and prefinished items.
 - 2. Prefinished items include the following factory-finished components:
 - a. Acoustical wall panels.
 - b. Metal toilet enclosures.
 - c. Finished mechanical and electrical equipment.
 - d. Light fixtures.
 - e. Distribution cabinets.
 - 3. Finished metal surfaces include the following:
 - a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper.
 - e. Bronze and brass.
- D. Operating Parts:
 - 1. Do not paint operating parts.
 - 2. Operating parts include the moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
- E. Labels:
 - 1. Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels, or name, identification, performance rating, or nomenclature plates on equipment.

3.04 APPLICATION

- A. Coating Material Preparation:
 - 1. Mix and prepare coating materials according to manufacturer's written instructions.
 - 2. Keep containers used for mixing and applying coatings clean and free of foreign materials and residue.
 - 3. Before applying paint, stir the materials to produce a mixture of uniform density.
 - a. Stir the material as required during application.
 - b. Do not stir surface film into the material.
 - c. If necessary, remove film and strain the coating material before use.
 - 4. Use only the type of thinners approved by manufacturer and only within recommended limits.
- B. Applying Paint:



1. Paint colors are identified on the Contract Drawings or will be selected during the Shop Drawing process by the Program/Project Manager from the manufacturer's standard colors.
2. Finishes are indicated in the Paint Schedules at the end of this Section.
3. Apply paint according to the manufacturer's written instructions.
4. Use applicators and techniques best suited for substrate and type of material being applied.
5. The number of coats and film thickness required is the same regardless of the application method.
 - a. Apply the first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - b. Provide finish coats that are compatible with primers used.
 - c. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer.
 - d. Where sanding is required to produce an even smooth surface, sand between applications in accordance with the manufacturer's directions.
 - e. Ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
6. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint until the paint film is of uniform finish, color, and appearance.
 - a. Extend coatings on exposed surfaces as required to maintain the coating system integrity and provide the desired protection.

C. Special Techniques:

1. Prime Coats:
 - a. Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others.
 - b. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in the first coat appears to ensure a finish coat with no burn through or other defects due to insufficient sealing.
2. Pigmented (Opaque) Finishes:
 - a. Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage.
 - b. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable.
3. Stipple Enamel Finish:
 - a. Roll and redistribute paint to an even and fine texture.
 - b. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
4. Block Fillers:



- a. Apply block fillers to concrete masonry block at a rate ensuring complete coverage that fills the pores.
 - b. Levels of CMU Block Filling:
 - 1) PDCA Technical Paper AZP-P07-89 defines 4 levels of CMU Block Filling as follow:
 - a) Level 1 – Regular Fill:
 - (1) Reduces quantity of paint required.
 - (2) Eliminates seemingly bottomless holes in masonry, reduces irregularity in masonry profile, one coat spray applied. (minimum block fill)
 - b) Level 2 – Medium Full Fill:
 - (1) Sufficiently fills and seals masonry to provide solid continuous surface for paint.
 - (2) Masonry profile slightly reduced, one coat spray applied and back rolled.
 - (3) Joints read natural.
 - c) Level 3 – Full Fill:
 - (1) Coats as required to conceal most of masonry texture, produce easy cleaning surface for to meet health regulations.
 - (2) Minimum fill for semi and high gloss finish, spray applied and backrolled.
 - d) Level 4 – High Density Fill:
 - (1) Minimum of 3 coats.
 - (2) First coat massaged and forced into the masonry texture to assure uniform high density.
 - (3) Second coat, with build sufficient to fully conceal masonry texture and joints.
 - (4) Additional coats as required to level.
 - (5) Squeegee for smooth, sand added to achieve light sand texture.
 - (6) Nominal thickness: 1/16 inch.
- D. Interface with Other Work:
- 1. Equipment and Furniture:
 - a. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.
 - b. Paint surfaces behind permanently fixed equipment or furniture before installing the equipment only with a prime coat.
 - c. Paint the backs of access panels and removable or hinged covers to match exposed surfaces.
 - 2. Doors:
 - a. Finish the tops, bottoms, and side edges of exterior doors the same as their exterior faces.
 - 3. Mechanical and Electrical Work:



- a. Limit painting mechanical and electrical work to exposed items in equipment rooms and in occupied spaces.
- b. Mechanical items to be painted include, but are not limited to, the following:
 - 1) Piping, pipe hangers, and supports.
 - 2) Heat exchangers.
 - 3) Tanks.
 - 4) Ductwork.
 - a) Paint interior surfaces of ducts visible through registers or grilles with a flat, nonspecular, black paint.
 - 5) Insulation.
 - 6) Motors and mechanical equipment.
 - 7) Accessory items.
- c. Electrical items to be painted include, but are not limited to, the following:
 - 1) Conduit and fittings.
 - 2) Switchgear.
 - 3) Panelboards.

3.05 REPAIR/RESTORATION

- A. Correct damage to paint by cleaning, repairing, replacing, and repainting as approved by Program/Project Manager; and leave the paint in an undamaged condition.
 - 1. At the completion of construction activities performed by other trades, touch up and restore damaged or defaced painted surfaces.
 - 2. Comply with the procedures specified in PDCA P1.

3.06 RE-INSTALLATION

- A. After completing painting operations in each space or area, reinstall items that were removed to facilitate the painting operations using workers skilled in the trades involved.

3.07 SITE QUALITY CONTROL

- A. Inspections:
 - 1. Inspect the completed Work to insure it matches the approved samples for color, texture, and coverage.
- B. Non-Conforming Work
 - 1. Remove, refinish, or repaint work not in compliance with specified requirements.
- C. Manufacturer Services:
 - 1. At the completion of the Work of this Section, submit either the manufacturer's or distributor's numbered invoices showing the type and



quantity of products used on this Contract to the Program/Project Manager for information.

3.08 CLEANING

- A. After completing painting, clean glass and paint-spattered surfaces.
 - 1. Remove spattered coatings by washing, scraping, or other methods.
 - 2. Do not scratch or damage adjacent finished surfaces.
- B. After completing coating operations, remove temporary protective wrappings provided by others to protect their Work.
- C. Waste Management:
 - 1. At the end of each workday, remove rubbish, empty cans, rags, and other discarded materials from the Site.

3.09 PROTECTION

- A. Provide "Wet Paint" signs to protect newly painted finishes.

3.10 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
 - 1. Table 09912-1 Exterior Paint Schedule.
 - 2. Table 09912-2 Interior Paint Schedule.

END OF SECTION

Table 09912-1 Exterior Paint Schedule ¹		
Substrate	System	Dunn-Edwards Corp. No.
Ferrous Metals	Refer to Section 09960, High-Performance Coatings	
Galvanized Metals	Refer to Section 09960, High-Performance Coatings	
Exterior Masonry	100% Acrylic Semi-Gloss Enamel	
Filler Coat(s) – Level 2 (PDCA)	BLOC-FIL latex block filler	W305
Primer Coat	EFF STOP acrylic masonry primer/sealer	W709
Two Coats	PERMASHEEN acrylic semigloss enamel	W901

**Table 09912-1 Exterior Paint Schedule¹**

Substrate	System	Dunn-Edwards Corp. No.
Exterior Gypsum Ceilings	100% Acrylic Copolymer Eggshell	
Primer Coat	Multi-purpose Primer	W713
Two Coats	Versawall latex flat enamel	W6230
1. Colors: Standard colors to be selected by the Program/Project Manager.		

Table 09912-2 Interior Paint Schedule¹

Substrate	System	Dunn-Edwards Corp. No.
Interior Drywall Surfaces, including ceilings		
Semi-Gloss		
Primer Coat	Self-priming first coat	
Two Coats	Spartawall acrylic semi-gloss paint	SWLL50-1
Flat		
Primer Coat	Self-priming first coat	
Two Coats	Spartawall acrylic flat paint	SWLL10-1
Eggshell		
Primer Coat	Self-priming first coat	
Two Coats	Spartawall acrylic eggshell paint	SWLL30-1
Interior Solid Core Doors and Woodwork	Acrylic Gloss Enamel	
Primer Coat	INTER-KOTE, Acrylic Enamel Undercoater	W 6325
Two Coats	SPARTAGLOSS, Interior/Exterior Acrylic Gloss Paint	W 7600
Interior Architecturally Exposed Structural Steel (AESS)		
Spot Prime	Organic zinc rich primer as required	-

**Table 09912-2 Interior Paint Schedule¹**

Substrate	System	Dunn-Edwards Corp. No.
Two Coats	Carboline Santile 255	-
Interior Metals		
Primer Coat	ULTRA-GRIP, Acrylic Multi-Purpose Primer	W 715
Two Coats	SPARTAGLOSS, Interior/Exterior Acrylic Gloss Paint	W 7600
1. Colors: Standard colors to be selected by the Program/Project Manager.		

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.3, 1.02.C.9, 1.04.B.2	Add requirements for ENVISION Sustainability Rating System



SECTION 09960

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for high-performance exterior coatings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 09912 – Painting.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Definitions:
 - 1. Standard coating terms defined in ASTM D 16 apply to the Work of this Section.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM D 16 – Terminology for Paint, Related Coatings, Materials, and Applications.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. Painting and Decorating Contractors of America (PDCA):
 - a. PDCA P1 – Touch-Up Painting And Damage Repair: Financial Responsibility.
 - 4. Steel Structures Painting Council (SSPC):



- a. SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
- b. SSPC Steel Structures Painting Manual – Good Painting Practice.
- c. SSPC Steel Structures Painting Manual – Systems and Specifications.
- 5. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Review other Specification Sections in which primers or other coatings are provided to ensure compatibility of the total systems for various substrates.
 - a. Upon request, furnish information on the characteristics of specified finish materials to ensure compatible primers.
 - b. Notify the Program/Project Manager of problems anticipated using the materials specified.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) High/Build Surface Tolerant Epoxy Primer for ferrous metal.
 - 2) Acrylic Polyurethane Enamel for ferrous metal.
 - 3) High/Build Surface Tolerant Epoxy Primer for non-ferrous and galvanized metal.
 - 4) Acrylic Polyurethane Enamel for non-ferrous and galvanized metal.
 - 5) Manufacturer's material data and certificates of performance for proposed substitutions.
 - b. Samples:
 - 1) Substrate Samples.
 - c. Certificates:
 - 1) High-Performance Coating Manufacturer's Certification.
 - d. Delegated Design Submittals:
 - 1) High-Performance Coating Material List.
 - e. Qualification Statements:
 - 1) Applicator's Qualifications.

- B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material.
 - b. Manufacturer's Reports:
 - 1) Manufacturer's color charts.
 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coating within the building's weather barrier.
- C. Maintenance Material Submittals:
1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Furnish an additional 10 gallons of high-performance coating materials, as appropriate, of each material and color applied.
 - a) Furnish extra high-performance coating materials from the same production run as materials applied.
 - b) Package these coating materials in unopened, factory-sealed containers suitable for storage, and identify the containers with labels describing the contents of each.
 - c) In addition to the instructions attached to paint containers, submit 2 copies of the mixing formula to the Program/Project Manager.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
1. Comply with the Occupational Safety and Health Administration (OSHA) regulations stipulated in 29 CFR 1910 and 29 CFR 1926.
 2. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
1. Applicator's Qualifications:
 - a. Engage an experienced applicator who has completed high-performance coating system applications similar in extent to that required for this Contract, and applying materials similar to those indicated for this Contract and having a record of successful in-service performance.



- b. Submit the applicator's qualifications to the Program/Project Manager for approval.
 - C. Certifications:
 - 1. High-Performance Coating Manufacturer's Certification:
 - a. Submit a High-Performance Coating Manufacturer's Certification from the manufacturer certifying that the products supplied comply with requirements specified that limit the amount of VOCs in the high-performance coating products.
 - D. Site Samples:
 - 1. Substrate Samples:
 - a. Submit Samples for each type of finish-coat material specified on the following substrates for the Program/Project Manager's review of color and texture:
 - 1) Ferrous metal.
 - a) Provide Samples of each type of topcoat product specified for final selection of the type of product to apply by the Program/Project Manager
 - 2) Nonferrous metal.
 - b. Provide two 4-inch square samples of flat metal and two 8-inch long samples of solid metal for each color and finish.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver materials to the Site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
 - 2. Materials not displaying manufacturer's product identification are unacceptable.
- B. Storage and Handling Requirements:
 - 1. Store high-performance coating materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees Fahrenheit.
 - 2. Store opened containers of high-performance coating in a clean condition, free of foreign materials and residue.
 - 3. Keep the storage area neat and orderly.
 - a. Remove oily rags and waste daily.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Apply high-performance coatings only when temperature of surfaces to be coated and the surrounding air temperatures are between 45 and 95



degrees Fahrenheit, or in accordance with the manufacturer's published recommendations.

2. Do not apply coatings under the following conditions:
 - a. When it is snowing, raining, foggy, or misty where the coating operation is occurring.
 - b. When the relative humidity exceeds 85 percent.
 - c. When temperatures are less than 5 degrees Fahrenheit above the dew point.
 - d. When the surfaces are damp or wet.
3. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing the coating operation.
4. Protect materials from freezing.

PART 2 PRODUCTS

2.01 EXTERIOR HIGH-PERFORMANCE COATING SYSTEMS

A. Manufacturers:

1. Manufacturer List:

- a. Dunn-Edwards Corporation, <https://www.dunnedwards.com/>.
- b. ICI Dulux Paints; Devoe Coatings, www.dulux.com.
- c. International Protective Coatings; International Paint, Inc. distributed by Akzo Noble N. V., www.international-pc.com.
- d. Pittsburgh Paint; PPG Industries, Inc., www.pittsburghpaints.com.
- e. Tnemec Company, Inc., www.tnemec.com.
- f. Approved equal.

2. Substitution Limitations:

- a. This Specification is written naming products manufactured by International Coatings distributed by Dunn-Edwards Paints.
 - 1) The use of a manufacturer's proprietary product names to designate colors or materials is not intended to imply that the products named are required to be used to the exclusion of equivalent products of other manufacturers.
- b. Submit the manufacturer's material data and certificates of performance for proposed substitutions.

3. Product Options:

- a. Subject to compliance with the Contract requirements, provide one of the products indicated in the coating system descriptions.
- b. Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

B. Sustainable Requirements:

1. Volatile Organic Compounds (VOC) Content of Field-Applied Interior Paints and Coatings:



- a. Provide paint products having volatile organic compound content, exclusive of colorants added to a tint base, not greater than the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - 1) Flat, Non-Flat and High-gloss Paints and Coatings: Not more than 50 grams per Liter.
 - 2) Primers, Sealers and Undercoats: Not more than 100 grams per Liter.
 - 3) Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: Not more than 100 grams per Liter.
 - 4) Floor Coatings: Not more than 50 grams per Liter.
 - b. Refer to Section 01360 of this specification for a complete list of VOC limits for this project.
- C. Design Criteria:
 - 1. Material Compatibility:
 - a. Provide primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated in the Contract Documents under the conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
 - 2. Material Quality:
 - a. Provide the manufacturer's highest grade of the various high-performance coatings specified.
 - 3. VOC Classification:
 - a. Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 100 grams per Liter or less.
 - 4. Colors:
 - a. Provide colors as selected by the Program/Project Manager from the manufacturer's full range.
 - 1) For specific colors of special coatings, refer to Section 09912, Painting.
 - b. Submit the manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated herein to the Program/Project Manager for information.
 - 5. Product Data:
 - a. Submit Product Data for each coating system specified, including block fillers and primers, to the Program/Project Manager for approval.
 - b. High-Performance Coating Material List:
 - 1) Submit an inclusive High-Performance Coating Material List of the required coating materials to the Program/Project Manager for approval.
 - a) Indicate each material, and cross-reference the specific coating, finish system, and application.



- b) Identify each material by the manufacturer's catalog number and general classification.
 - c. Manufacturer's Information:
 - 1) Submit the manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified to the Program/Project Manager for information.
- D. Materials:
 - 1. High-Performance Coatings for Ferrous Metal:
 - a. Provide the following finish systems over exterior ferrous-metal surfaces:
 - 1) Primer: Bloc-Rust Premium BRPR00 Series White or Red Oxide (depends on color of topcoat – light colors use white dark colors use red).
 - 2) 2 coats Evershield Ext. 100% Acrylic Velvet Paint: EVSH20
 - 2. High-Performance Coatings for Non-Ferrous and Galvanized Metal:
 - a. Provide the following finish systems over exterior non-ferrous-metal surfaces:
 - 1) Primer: Ultrashield Galvanized Metal Primer ULGM00
 - 2) 2 coats Evershield Ext. 100% Acrylic Velvet Paint: EVSH20

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the Applicator present, examine the substrates and conditions under which the high-performance coatings will be applied for compliance with coating application requirements.
- B. Evaluation and Assessment:
 - 1. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
 - 2. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
 - a. The start of coating application is construed as the Applicator's acceptance of the surfaces within that particular area.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect the Work of other trades, whether being coated or not, against damage from coating operations.



2. Take the necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying the coatings.

B. Surface Preparation:

1. For each substrate condition, clean and prepare the surfaces to be coated according to the manufacturer's written instructions and as specified herein.
2. Before applying high-performance coatings, clean the substrates of substances that could impair the bond of the coatings.
 - a. Remove oil and grease before cleaning.
 - b. Schedule the cleaning and coating application so dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.
3. Ferrous-Metal Substrates:
 - a. Clean ungalvanized ferrous-metal surfaces that have not been shop coated.
 - 1) Remove oil, grease, dirt, loose mill scale, and other foreign substances.
 - 2) Use solvent or mechanical cleaning methods that comply with recommendations provided in the SSPC Steel Structures Painting Manual.
 - b. Blast Cleaning:
 - 1) Blast clean the ferrous-metal substrates in accordance with the requirements specified in SSPC-SP 6/NACE No. 3.
4. Nonferrous-Metal Substrates:
 - a. Clean nonferrous and galvanized surfaces according to the manufacturer's written instructions for the type of service, metal substrate, and application required.
 - b. Blast Cleaning:
 - 1) Blast clean the nonferrous-metal substrates in accordance with the requirements specified in SSPC-SP 6/NACE No. 3.

C. Demolition/Removal:

1. Remove plates, machined surfaces, and similar items already in place that are not to be coated.
 - a. If removal of these items is impractical or impossible because of the size or weight of the items, provide surface-applied protection before initiating surface preparation and coating.

3.03 APPLICATION

A. Material Preparation:

1. Carefully mix and prepare coating materials according to manufacturer's written instructions.



2. Keep containers used for mixing and applying coatings clean and free of foreign materials and residue.
 3. Before applying coating materials, stir the materials to produce a mixture of uniform density.
 - a. Stir the material as required during application.
 - b. Do not stir surface film into the material.
 - c. Remove film and, if necessary, strain the coating material before use.
 4. Use only the type of thinners approved by manufacturer and only within recommended limits.
- B. Paint all exterior exposed metals (ferrous and non-ferrous) using the products specified herein.
1. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied.
 2. Tint undercoats to match the color of finish coat, but provide a sufficient difference in the shade of undercoats to distinguish each separate coat.
- C. Apply high-performance coatings according to the manufacturer's written application instructions.
1. Use applicators and techniques best suited for the material being applied.
 2. Apply a second coat only after the first coat is thoroughly dry.

3.04 REPAIR/RESTORATION

- A. Correct damage to high-performance coatings by cleaning, repairing, replacing, and recoating as approved by Program/Project Manager; and leave the coatings in an undamaged condition.
1. At the completion of construction activities performed by other trades, touch up and restore damaged or defaced coated surfaces.
 2. Comply with the procedures specified in PDCA P1.

3.05 RE-INSTALLATION

- A. After completing coating operations, reinstall items that were removed to facilitate the coating operations using workers skilled in the trades involved.

3.06 CLEANING

- A. After completing the coating application, clean spattered surfaces.
1. Remove spattered coatings by washing, scraping, or other methods.
 2. Do not scratch or damage adjacent finished surfaces.
- B. After completing coating operations, remove temporary protective wrappings provided by others to protect their Work.
- C. Waste Management:



1. At the end of each workday, remove rubbish, empty cans, rags, and other discarded materials from the Site.

3.07 PROTECTION

- A. Provide "Wet Paint" signs to protect newly coated finishes.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/6/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.2, 1.02.B.2, 2.01.B.1	Add requirements for ENVISION Sustainability Rating System



SECTION 09961

FLUOROPOLYMER COATING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for high performance, baked on fluorocarbon finishes.
- B. Products Supplied But Not Installed Under This Section:
 - 1. This Section specifies fluorocarbon finishes to be applied to items provided under other Sections which may or may not include, and are not limited to, the following:
 - a. Metal fabrications.
 - b. Expansion joint cover assemblies.
 - c. Manufactured wall panels.
 - d. Sliding automatic entrance doors.
 - e. Aluminum curtainwall systems.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07920 – Joint Sealants.

1.02 REFERENCES

- A. Definitions:
 - 1. Standard coating terms defined in ASTM D 16 apply to the Work of this Section.
 - 2. NBS Unit: Short for the National Bureau of Standards (NBS) Unit of Color Difference, a unit to describe the size of the difference, ΔE , between 2 colors of tristimulus specifications based on Equation 13 in the now obsolete NBS Circular C429, Photoelectric Tristimulus Colorimetry with Three Filters.
 - 3. Specular Gloss: The relative luminous reflectance factor of a specimen in the mirror direction.
- B. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Architectural Manufacturer's Association (AAMA):



- a. AAMA 609 & 610 – Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document).
- b. AAMA 2604 – Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
3. ASTM International (ASTM):
 - a. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - b. ASTM B 244 - Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy Current Instruments.
 - c. ASTM D 16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - d. ASTM D 523 - Standard Test Method for Specular Gloss.
 - e. ASTM D 714 - Standard Test Method for Evaluating Degree of Blistering of Paints.
 - f. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
 - g. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - h. ASTM D 2244 - Standard Practice for Calculation of Color Tolerance and Color Differences from Instrumentally Measured Color Coordinates.
 - i. ASTM D 2247 - Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity.
 - j. ASTM D 3363 - Standard Test Method for Film Hardness by Pencil Test.
 - k. ASTM D 4214 - Standard Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
 - l. ASTM D 7091 - Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
4. International Organization for Standardization (ISO):
 - a. ISO 9001 – Quality Management System – Requirements.
5. United States Government:
 - a. United States General Services Administration (GSA):
 - 1) Federal Standards:
 - a) FED-STD-595 – Colors Used in Government Procurement.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the application, shipping, handling, inspection, repair, cleaning, and warranty requirements specified under this Section with the requirements specified for the fluoropolymer coated items provided under other Sections.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Thermo-cured fluorocarbon system.
 - b. Samples:
 - 1) Samples representing the degree of specular gloss and color of the finishes.
 - c. Certificates:
 - 1) Fluoropolymer Coating Certificate of Compliance.

B. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Instructions for cleaning the finishes, and for repairing damaged finishes.
 - b. Warranty Documentation:
 - 1) Applicator's Warranty.

C. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Touchup Materials:
 - a) For each finish provided, furnish 1 quart of air drying type touch-up material matching the finish, and packaged for storage by having protective coverings and labels identifying the contents and indicating they are maintenance material for the Owner.
 - (1) Spray cans are acceptable only if they are standard with the coating manufacturer.



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer's Qualifications:

- a. Unless accepted otherwise by the Program/Project Manager, obtain products from manufacturers that employ a Quality Management System complying with the program described in ISO 9001, or a similar system.
- b. Submit proof on the manufacturer's qualifications to the Program/Project Manager for approval.

2. Applicator's Qualifications:

- a. Unless accepted otherwise by the Program/Project Manager, employ applicators that have in-place a Quality Management System complying with the program described in ISO 9001, or a similar system.
- b. Only factory-apply and oven cure fluorocarbon finishes in plants of applicators approved by the licensed formulators.
- c. Submit the applicator's qualifications to the Program/Project Manager for approval.

B. Certifications:

1. Fluoropolymer Coating Certificate of Compliance:

- a. Submit the fluoropolymer coating manufacturer's Certificate of Compliance certifying that the fluoropolymer coating products comply with the specified requirements.

C. Site Samples:

1. For each fluoropolymer coating finish, submit a Sample representing the degree of specular gloss and color of the finish to the Program/Project Manager for approval.
 - a. Prepare the Samples in accordance with the manufacturer's printed instructions.
 - b. Provide 3 samples, each not less than 150mm square, applied on the same type of metal which will be used in the finished system.
 - c. If more than one applicator is employed, provide the required Samples from each applicator providing the special metal finishes.
 - d. Provide custom color Samples, to match the Program/Project Manager's samples, for approval in coordination with the requirements of the construction schedules.
 - e. For items finished by a given applicator and finishes applied by different applicators, the color and gloss will be required to match.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Package, ship, and unload the finished product in accordance with the requirements specified in AAMA 2604.
 - 2. Wrap coated units in protective corrugated board containers.
- B. Storage and Handling Requirements:
 - 1. Store the finished product onsite in accordance with the requirements specified in AAMA 2604.
 - 2. Do not remove the corrugated board containers until the units are ready for installation.
 - 3. Install the finished product within 6 months from the date of shipment from the manufacturer.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Special Warranty:
 - 1. Applicator's Warranty:
 - a. Furnish an Applicator's Warranty for the quality and maintenance of the fluoropolymer coating finishes on the applicator's standard form in which the applicator agrees to repair finishes or replace items that show evidence of the deterioration of factory-applied finishes within 10 years from the date of Substantial Completion.
 - b. Submit the Applicator's Warranty to the Program/Project Manager.

PART 2 PRODUCTS

2.01 FLUOROPOLYMER COATING SYSTEM

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified and approval by the Program/Project Manager, products from other manufacturers may be provided.



B. Description:

1. Provide a fluoropolymer coating system consisting of the primer and finish coats, each spray-applied by an approved applicator at the factory, and force-cured in accordance with the coating manufacturer's current printed instructions.

C. Performance:

1. Provide a fluoropolymer coating system having or exceeding the following characteristics as determined in accordance with the requirements specified in AAMA 2604 and herein:
 - a. Specular Gloss: 25 to 35 (medium) when measured in accordance with the methods specified in ASTM D 523 using the 60-degree geometry.
 - b. Dry Film Thickness:
 - 1) Provide a fluoropolymer coating system having the following dry film thicknesses when measured in accordance with the requirements specified in ASTM D 1400:
 - a) Primer: 0.25 mil, plus or minus 0.05 mil.
 - b) Barrier Coat, if required: 1.0 mil, minimum.
 - c) Color Coat: 1.0 mil, minimum.
 - d) Clear Top Coat: 0.6 mil, plus or minus 0.2 mil.
 - c. Pencil Hardness: Complies with or exceeds the requirements for F lead scratch hardness when measured in accordance with the method specified in ASTM D 3363.
 - d. Cross Hatch Adhesion: No removal with crosshatch, 1/16 inch wet and dry.
 - e. Direct Impact: No removal with direct impact, 0.10 inch distortion.
 - f. Abrasion Resistance: Has an abrasion resistance value equal to 40 to 80 liters per mil when tested in accordance with the method specified in ASTM D 968.
 - g. Salt Spray Resistance: 1/16 inch maximum undercutting when exposed to a 5 percent salt solution at 100 degrees Fahrenheit for 4000 hours in accordance with the method specified in ASTM B 117.
 - h. Humidity Resistance: Exhibiting a maximum of a few number 8 blisters when exposed to 100 percent relative humidity at 100 degrees Fahrenheit for 4000 hours in accordance with the methods specified in ASTM D 714 and ASTM D 2247.
 - i. Acid Resistance: Exhibiting no effects of attack when exposed to a 10 percent solution of muriatic acid for 15 minutes in accordance with the Spot Test specified in ASTM D 1308.



- j. Alkali Resistance: Exhibiting no effects of attack when exposed to alkali for 24 hours in accordance with the requirements of the Mortar Pat Test.
- k. Detergent Resistance: Exhibiting no effects of attack when immersed in a 3 percent detergent solution at 100 degrees Fahrenheit for 72 hours.
- l. Resistance to Acid Pollutants: Exhibiting a maximum NBS color difference of 5 NBS Units.
- m. Weathering Color Retention: Exhibiting a maximum color difference of 5E after exposure in accordance with the requirements specified in ASTM D 2244 at 45 degrees for period of 10 years.
- n. Chalk Resistance: Exhibiting a maximum Chalk Rating of 8.0 after exposure in accordance with the requirements specified in ASTM D 4214 at 45 degrees for a period of 10 years.
- o. Erosion: Exhibiting a maximum film loss of 5 percent after exposure in accordance with the requirements specified in ASTM B 244 at 45 degrees for a period of 10 years.

D. Design Criteria:

- 1. Provide a thermo-cured fluorocarbon system complying with the requirements specified in AAMA 2604, and consisting of a specially formulated inhibitive primer, fluorocarbon color coat, and clear topcoat designed for application on exposed to view metal surfaces.
 - a. Provide a fluorocarbon system containing not less than 70 percent polyvinylidene fluoride resin by weight.
- 2. Colors:
 - a. Provide colors as selected by the Program/Project Manager from the manufacturers standard color range.
- 3. Product Data:
 - a. Prepare Product Data for the thermo-cured fluorocarbon system including the finish formulator's technical information.
 - 1) Include a basic materials analysis for each material specified.
 - 2) List each material, and cross-reference the material to the specific coating and finish system and application.
 - 3) Identify the system by the manufacturer's catalog number and general classification.
 - 4) List coating-compatible sealants acceptable to the system manufacturer, and meeting or exceeding the requirements of Section 07920, Joint Sealants, for adhesion.

E. Factory Assembly

- 1. Fabricate and assemble the products finished in accordance with the requirements specified in AAMA 2604.



F. Finishes:

1. Provide an AA-C12C42R1x finish.
 - a. Finish designations prefixed by AA refer to finishes defined by the system for designating aluminum finishes established by the Aluminum Association and specified in AA DAF-45.
 - b. An AA-C12C42R1x finish is defined to have the following components:
 - 1) Chemical Finish: Cleaned with inhibited chemicals.
 - 2) Chemical Finish: Chemical conversion coating, acid chromate-fluoride-phosphate pretreatment.
 - 3) Organic Coating:
 - a) Provide an organic coating as specified herein.
 - b) The basis of design system and standard of quality is PPG Industries, Inc. Duranar® XL, a 3-coat fluoropolymer finish system.
2. Primer Materials:
 - a. Provide the manufacturer's specially formulated inhibitive primer.
3. Finish Materials:
 - a. Organic Coating:
 - 1) Provide a first color coat consisting of a fluoropolymer with metallic flakes containing not less than 70 percent polyvinylidene fluoride resin by weight, and complying with the requirements specified in AAMA 2604.
 - a) Provide a fluorocarbon top finish color coating having a minimum baking cycle of 232 degrees Celsius for 20 minutes, and a minimum dry film thickness of 0.025mm.
 - 2) Provide a second clear fluorocarbon topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, and complying with the requirements specified in AAMA 2604.
 - 3) Manufacturers:
 - a) Arkema in North America, (Kynar 500®), <https://arkema-america.com>.
 - b) PPG Industries, Inc., Duranar® XL (Kynar 500®), <http://corporate.ppg.com/Home.aspx>.
 - c) Solvay Solexis, Hylar® 5000, <https://www.solvay.com/en/markets-and-products/featured-products/hylar.html>.
 - d) Valspar, (Kynar 500®), <https://www.kynar500.com/en/consistency-through-licensing/americas-licensees/valspar-corporation/>.
 - e) Approved equal.
4. Shop Finishing Methods:



- a. Remove hardware, hardware accessories, machined surfaces, plates, and similar items which are not to be coated, or provide surface-applied protection prior to surface preparation and coating operations.
 - 1) If exposed fasteners have been approved, factory-finish the fasteners to match the other surfaces.
- b. Prepare, pretreat, and apply the coating to exposed metal surfaces in accordance with the coating and resin manufacturer's instructions.
 - 1) Prepare and clean the surfaces to receive the fluoropolymer castings in accordance with the coating manufacturer's instructions for the substrate conditions involved.
 - a) Before beginning to apply the coating, remove pronounced die markings on extruded aluminum by using mechanical finishing techniques.
 - 2) Chemical Finish:
 - a) Prior to applying the primer, thoroughly clean the metal, and provide a chromate conversion coating pretreatment.
 - (1) Clean the substrate with inhibited chemicals.
 - (2) Provide an acid chromate-fluoride-phosphate pretreatment and chemical conversion coating.
 - 3) Fluoropolymer Coating System:
 - a) After fabrication of the base unit, spray-apply an acid resistant primer and top coatings.
 - (1) Apply a 3-coat fluoropolymer coating system consisting of the primer, a color coat, and a clear coat.
- c. After the base unit and adjacent surfaces are completely coated, replace the hardware, hardware accessories, machined surfaces, plates, and similar items removed to keep them from being coated.

2.02 ACCESSORIES

- A. Sealants:
 - 1. Provide coating-compatible sealants complying with or exceeding the requirements for adhesion specified in Section 07920, Joint Sealants.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Quality Control Test:
 - a. Test Procedure:
 - 1) The applicator must follow the manufacturer's guidelines for quality control testing on a prescribed schedule during production.
 - b. Acceptance Criteria:



- 1) Coatings, when cured, must be visibly free of dust, dirt, flow lines, streaks, sags, holidays, blisters, pinholes, runs, curtains, and other surface imperfections.

B. Non-Conforming Work:

1. Do not ship items failing the Quality Control Test to the Site.

PART 3 EXECUTION

3.01 APPLICATORS

A. Applicator List:

1. Hylar 5000 Licensees, <https://www.solvay.com/en/markets-and-products/featured-products/hylar.html>.
2. PPG Certified Applicators, http://corporateportal.ppg.com/NA/IdeaScapes/sourcing/CAP_Locations.htm.
3. Valspar Approved Applicators, <https://www.valsparcoilextrusion.com/en/resources/applicators/>.
4. Approved equal.

B. Substitution Limitations:

1. Subject to compliance with the coating manufacturer's licensing agreements, and approval by the Program/Project Manager, other applicators may be employed.

3.02 REPAIR

A. Field Touch-Up and Repair:

1. If minor touch-up Work is allowed by Program/Project Manager, touch-up installed units that, in the opinion of the Program/Project Manager, are scratched, abraded or otherwise damaged in the field.
 - a. Repair those surfaces showing minor defects by spray-applying an air-drying maintenance coating recommended by the fluorocarbon coating manufacturer, supplied by the licensed formulator, and having the same color as the installed unit, onto the surfaces.
 - b. Do not use the Owner's maintenance stock for touch-up Work.

3.03 SITE QUALITY CONTROL

A. Site Inspections:

1. Correct repair and touch-up work that is unacceptable to the Program/Project Manager, and request a final inspection for acceptance of the Work by the Program/Project Manager.



B. Non-Conforming Work

1. Unacceptable Finishes:

- a. Unacceptable color, film characteristics, or damage, as determined by the Program/Project Manager, are cause for rejection of the entire coated section.
 - 1) Unacceptable Film Characteristics:
 - a) The coating cannot exhibit checking, crazing, chipping, or reticulation.
 - 2) Fading:
 - a) The coating cannot exhibit fading from the original color sample greater than 7 units as measured by an IDL color eye Model D.
 - 3) Non-Uniformity:
 - a) The coating cannot exhibit a non-uniformity discernible from a 3m distance, including smutting and chalking.
 - 4) Pitting and corrosion:
 - a) The coating cannot exhibit pitting and corrosion discernible from a 3m distance.
- b. If the Program/Project Manager decides that touch-up repairs will not sufficiently remedy the defects or damage, replace the defective or damaged unit with an undamaged factory-finished unit at no increase in the Contract Price.

3.04 CLEANING

- A. Clean installed items coated with fluoropolymer in accordance with the requirements specified in AAMA 609 and AAMA 610 (Combined Document).

3.05 PROTECTION

- A. Take steps to ensure that installed fluoropolymer coated items are protected during subsequent construction activities.

3.06 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit instructions for cleaning the finishes, and for repairing damaged finishes, to the Program/Project Manager.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 09967

INTUMESCENT PAINTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for epoxy intumescent fire protection applied to steel structures and supports at the locations indicated on the Contract Drawings.
- B. Products Supplied But Not Applied Under This Section:
 - 1. Primer Coating:
 - a. The shop primer coating furnished under this Section will be applied to structural steel and framing under Section 05120, Structural Steel.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 05120 - Structural Steel.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. DFT: Dry film thickness.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
 - 4. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 5. WFT: Wet film thickness.
- B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Intumescent: A substance that swells as a result of heat exposure, thus increasing its volume and decreasing its density.

C. Reference Standards:

1. Association of the Wall and Ceiling Industry (AWCI):
 - a. AWCI Technical Manual 12-B - Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide.
2. ASTM International (ASTM):
 - a. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
 - b. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
 - c. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - d. ASTM D 2240 - Standard Test Method for Rubber Property--Durometer Hardness.
 - e. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - f. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
5. Green Seal, Inc. (GS):
 - a. GC-03 - Green Seal™ Environmental Criteria for Anti-Corrosive Paints.
 - b. GS-11 – Green Seal™ Environmental Standard for Paints and Coatings.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. International Organization for Standardization (ISO):
 - a. ISO 2812-1 - Paints and Varnishes -- Determination of Resistance to Liquids – Part 1: Immersion in Liquids other than Water.
 - b. ISO 2812-2 - Paints and Varnishes -- Determination of Resistance to Liquids – Part 2: Water Immersion Method.
 - c. ISO 4624 - Paints and Varnishes -- Pull-Off Test for Adhesion.
 - d. ISO 9001 – Quality Management Systems – Requirements.
 - e. ISO 12944-1 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 1: General Introduction.



- f. ISO 12944-2 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 2: Classification of Environments.
- g. ISO 12944-3 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 3: Design Considerations.
- h. ISO 12944-4 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 4: Types of Surface and Surface Preparation.
- i. ISO 12944-5 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 5: Protective Paint Systems.
- j. ISO 12944-6 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 6: Laboratory Performance Test Methods.
- k. ISO 12944-7 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 7: Execution and Supervision of Paint Work.
- l. ISO 12944-8 - Paints and Varnishes -- Corrosion Protection of Steel Structures by Protective Paint Systems – Part 8: Development of Specifications for New Work and Maintenance.
- m. ISO 20340 – Paints and Varnishes -- Performance Requirements for Protective Paint Systems for Offshore and Related Structures.
- 8. Intertek Group plc:
 - a. Intertek Directory of Listed Product Search, <http://etlwhidirectory.etlsemko.com>.
 - 1) Warnock Hersey Mark Directory.
- 9. National Fire Protection Association (NFPA):
 - a. NFPA 101 – Life Safety Code.
- 10. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1113 – Architectural Coatings.
- 11. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-SP 6/NACE No. 3 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
- 12. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - b. UL 263 – Standard for Fire Tests of Building Construction and Materials.
- 13. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Review other Specification Sections in which primers or other coatings are provided for various substrates to ensure compatibility of the various elements of the total systems.
 - a. Upon request, information on the characteristics of specified finish materials will be furnished to ensure compatible primers.
 - b. Primer coating and decorative topcoats must be approved by the intumescent fireproofing manufacturer, and must be applied in accordance with the primer coating and topcoat manufacturers' documented instructions respectively.
 - c. Notify the Program/Project Manager if problems using the materials specified are anticipated.

B. Sequencing:

1. Sequence and coordinate the application of the epoxy intumescent fireproofing Work of this Section with the Work of other Sections which would otherwise interfere with the efficient application of the fireproofing provided under this Section.
2. Do not commence the Work related to installation of piping, ducts, conduit, or other suspended equipment in an area until the application of epoxy intumescent material is complete in that area.
3. Do not apply epoxy intumescent materials to supporting structural steel until concrete toppings and/or roofing applications have been completed and are substantially dry.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Shop primer.
 - 2) Tie coat.
 - 3) Intumescent fireproofing.
 - 4) Top coat.
 - b. Shop Drawings:
 - 1) Intumescent fireproofing system.



- c. Samples:
 - 1) Samples of each finish product specified.
 - 2) Sets of color chips.
 - d. Certificates:
 - 1) Manufacturer's Conformance Certificates.
 - e. Qualification Statements:
 - 1) Manufacturer's qualifications.
 - 2) Applicator's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) UL design listings.
 - b. Manufacturer's Instructions:
 - 1) Intumescent fireproofing manufacturer's documented storage instructions.
 - 2) Primer coating manufacturer's documented application instructions.
 - 3) Intumescent fireproofing manufacturer's written requirements and application instructions.
 - 4) Top coat manufacturer's documented application instructions.
 - c. Site Quality Control Submittals:
 - 1) Random, pre-determined liquid samples of Component A and Component B.
 - 2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.
 - a. Paints and Coatings
 - 1) Submit product data highlighting the VOC content for any field applied coating within the building's weather barrier.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Intumescent Paint Warranty.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:



- 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
1. Manufacturer's Qualifications:
 - a. Procure intumescent paint products from a company specializing in manufacturing products similar to those listed in this Section, and that has a minimum of 10 years documented experience producing products similar to those required for the Work of this Section.
 - b. The manufacturer's quality management system must be assessed and registered by an independent registrar as conforming to the requirements of ISO 9001.
 - c. Submit the manufacturer's qualifications to the Program/Project Manager for approval.
 2. Applicator's Qualifications:
 - a. Employ a coating applicator specializing in applying the coatings similar to those required as the Work of this Section, and that has a minimum of 3 years documented experience and that is certified by the intumescent paint manufacturer.
 - b. Submit the applicator's qualifications, including current certification as a manufacturer trained and approved applicator, to the Program/Project Manager for approval.
- C. Certifications:
1. Manufacturer's Conformance Certificates:
 - a. Submit the intumescent fireproofing Manufacturer's Certificates, certifying that the intumescent fireproofing system being provided complies with the specified requirements, to the Program/Project Manager for approval.
 - 1) Include evidence of the complete intumescent paint system's compliance with the specified performance requirements.
 2. Fire Test Evidence:
 - a. Provide intumescent paint products that are manufactured under the appropriate follow-up service provided by an independent testing agency acceptable to the Authorities Having Jurisdiction (AHJ), with each container bearing the certified label (mark) for the application intended.



- b. Submit published UL design listings for the fire resistance ratings and product thicknesses required.
 - 1) Include evidence that the fire testing was sponsored by the manufacturer and that the material tested was produced at the manufacturers facility under the supervision of Underwriters Laboratories, Inc personnel.
 - 2) The UL Classification required is Mastic and Intumescent Coatings (CDWZ).
- D. Site Samples:
 - 1. Submit Samples of each finish product specified, and 2 complete sets of color chips representing the manufacturer's full range of available materials, to the Program/Project Manager for approval and finish selection.
- E. Mock-Ups:
 - 1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - a. Before proceeding with the production Work provided under this Section, have the Program/Project Manager witness the applicator apply the primer, intumescent fireproofing, and decorative top coat to a representative 100 square-foot section of the substrate in a location designated by the Program/Project Manager.
 - b. Apply the materials in accordance with the Contract requirements for fire rating thickness, finish texture, and color.
 - c. For the Stage 1A Terminal 3 Station, provide a mock-up of a minimum two foot high tube column using specified product and in accordance with the project requirements for fire rating thickness, manufacturer's recommended installation methods, for Architect's approval of finish color, texture, pattern and work standards. Before proceeding with work, observe final finish of Terminal 4 Station columns and requirements notes in Section 2.01.E.3.c.1.
 - 2. The mock-up is subject to the Program/Project Manager's approval, and once approved in writing will serve as a guide for the finished Work.
 - a. Do not proceed with remaining work until the workmanship, color, and sheen are approved by the Program/Project Manager.
 - b. Refinish the mock-up area as required to produce acceptable Work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver the intumescent fireproofing materials in the manufacturer's original, sealed, undamaged container having its identification label intact.
 - a. Packaged materials must bear the appropriate labels, seals, and UL label (mark) indicating the fire resistive ratings.
 - 2. Documentation:



- a. Record all batch numbers, product identification, and quantities on appropriate Quality Control documents.
 - b. Attach a copy of the transport document and the Manufacturer's Conformance Certificate to the material delivery Quality Control form.
- B. Storage and Handling Requirements:
 - 1. Store the intumescent fireproofing materials in strict accordance with manufacturers documented instructions.
 - a. Submit the intumescent fireproofing manufacturer's documented storage instructions to the Program/Project Manager for information.
 - 2. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of the local Authorities Having Jurisdiction.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Contamination Protection:
 - a. Protect the work area where intumescent fireproofing products will be applied from windblown dust and rain.
 - 2. Temperature, Humidity, and Ventilation Requirements:
 - a. In the areas where intumescent fireproofing products will be applied, maintain the air temperature and relative humidity before, during, and after application of these products in accordance with the manufacturer's requirements for a time period as recommended by the manufacturer.
 - b. Ventilate the areas where intumescent fireproofing products are being applied both during the application of the material, and for a minimum of 24 hours afterwards.
 - c. Starting 24 hours before application of the intumescent fireproofing material, and continuing until 24 hours after the material was applied, maintain temporary a temperature of at least 41 degrees Fahrenheit (5 degrees Celsius) in the work area.
 - 1) When the temperatures of the substrate and/or the surrounding ambient air temperature are below this minimum temperature, do not apply the epoxy intumescent fireproofing.
 - 2) For steel substrates, maintain the substrate temperature a minimum of 5 degrees Fahrenheit (3 degrees Celsius) above the dew point of the surrounding air for the 24-hour period prior to application and during the application of the material.



- d. Starting 24 hours before application of the intumescent fireproofing material, and continuing until 24 hours after the material was applied, maintain the relative humidity in the application area at 85 percent or less.
 - e. If necessary for keeping the Contract on schedule, furnish and maintain temporary enclosures, heat, and protection to maintain proper temperatures and humidity levels in the application areas.
- B. Existing Conditions:
 - 1. The surfaces to receive the intumescent fireproofing will have previously been shop-primed under other Sections.

1.08 WARRANTY

- A. Special Warranty:
 - 1. Warrant the intumescent paint materials and workmanship against failures within the 2 year period after the Date of Substantial Completion:
 - a. Submit this written Intumescent Paint Warranty on the manufacturer's standard form in which the manufacturer warrants the material against manufacturing defect, outlining its terms, conditions, and exclusions from coverage within the specified warranty period to the Program/Project Manager for approval.
 - b. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 INTUMESCENT FIRE PROTECTION SYSTEM

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain a complete intumescent fire protection system consisting of primer, tie coat, epoxy intumescent fireproofing, and topcoat from a single source and from a single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:



- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. Supplement the requirements of this Section with the requirements of the insurance rating organizations and other Authorities Having Jurisdiction.
 2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Field-Applied Interior Paints and Coatings:
 - 1) Provide paint products having volatile organic compound content, exclusive of colorants added to a tint base, not greater than the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - a) Primers, sealers and undercoaters: Not more than 100 grams per Liter.
 - b) Intumescent fireproof coating-clear: Not more than 350 grams per Liter.
 - c) Intumescent fireproof coating – pigmented: Not more than 650 grams per Liter.
 - d) Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: Not more than 100 grams per Liter.
 - b. Refer to Section 01360 – Sustainability Design Requirements for a complete list of VOC limits for this project.
- C. Performance:
 1. Provide an intumescent paint system complying with the following performance requirements:
 - a. Bond Strength:
 - 1) Provide an intumescent paint system having minimum bond strength of 1440 psi when measured in accordance with the method specified in ISO 4624.
 - b. Tensile Strength:
 - 1) Provide an intumescent paint system having minimum tensile strength of 1640 psi when measured in accordance with the method specified in ASTM D 638.
 - c. Compressive Strength:
 - 1) Provide an intumescent paint system having minimum compressive strength of 1500 psi when measured in accordance with the method specified in ASTM D 695.
 - d. Flexural Strength:
 - 1) Provide an intumescent paint system having minimum flexural strength of 1400 psi when measured in accordance with the method specified in ASTM D 790.
 - e. Durometer Hardness:



- 1) Provide an intumescent paint system having minimum durometer hardness of 60 Shore D when measured in accordance with the method specified in ASTM D 2240.
 - f. Surface Burning Characteristics:
 - 1) Provide an intumescent paint system having a Class A rating as defined in NFPA 101 when measured in accordance with the method specified in ASTM E 84.
 - g. Moisture Absorbance:
 - 1) Provide an intumescent paint system having less than 1 percent water uptake when measured in accordance with the method specified in ISO 2812-1.
 - h. Chemical Resistance:
 - 1) Provide an intumescent paint system passing the chemical resistance test performed in accordance with the method specified in ISO 2812-2.
 - i. Corrosion Resistance:
 - 1) Provide an intumescent paint system complying with the requirements for coatings used in corrosivity category C5-I environments as specified in the ISO 12944 series of standards.
 - j. Fireproofing:
 - 1) Provide an intumescent paint system tested by an independent testing agency, acceptable to the Authorities Having Jurisdiction (AHJ), in accordance with ASTM E 119/UL 263; and complying with the following fire resistance ratings:
 - a) Structural Steel Columns:
 - (1) Fire Resistance Rating: 2 hours.
 - (2) Design Number: BXUV.X678.
 - b) Structural Steel Beams:
 - (1) Fire Resistance Rating: 2 hours.
 - (2) Design Number: BXUV.X678.
 - c) Structural Concrete:
 - (1) Fire Resistance Rating: 3 hours.
- D. Design Criteria:
- 1. Provide a complete intumescent paint system consisting of a primer, tie coat, epoxy intumescent fireproofing, and a topcoat.
 - 2. Provide an intumescent fireproofing system capable of being exposed to moisture and not susceptible to microbial contamination.
 - 3. Product Data:
 - a. For each intumescent fireproofing system component indicated in the Contract Documents, submit Product Data to the Program/Project Manager for approval.
 - 1) Include the manufacturer's technical information indicating product performance characteristics, performance, and limitation criteria.
 - 4. Shop Drawings:



- a. For the intumescent fireproofing system, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Include plans, sections, elevations, and perspective drawings as necessary to depict the system configuration, design considerations, and application procedures.
- E. Finishes:
1. Primer Materials:
 - a. Shop Primer:
 - 1) Provide a zinc epoxy primer approved by the intumescent fireproofing manufacturer.
 2. Finish Materials:
 - a. Tie Coat:
 - 1) Provide a two-component epoxy primer suitable for overcoating a zinc silicate primed substrate after prolonged periods of weathering, and capable of preventing zinc salt formation on weathering and pinholing of subsequent high build topcoats.
 - 2) Manufacturers:
 - a) International Paint, LLC, Intergard 269, www.international-pc.com.
 - b) Approved equal.
 - b. Intumescent Fireproofing:
 - 1) Provide a plural component, 100 percent solids, zero volatile organic compounds (VOC) intumescent fire resistive coating system.
 - a) Provide a coating system listed by FM Approvals LLC (FM), Intertek Group plc (Warnock Hersey Mark Directory), or Underwriters Laboratories, Inc. (UL).
 - 2) Manufacturers:
 - a) International Paint, LLC, Interchar 212, www.international-pc.com.
 - b) Approved equal.
 - c. Top Coat:
 - 1) Provide a decorative topcoat approved by the intumescent fireproofing manufacturer.
 - 2) Manufacturers:
 - a) International Paint, LLC, Interthane 990HS, www.international-pc.com.
 - b) Approved equal.
 3. Shop Finishing Methods:
 - a. Surface Preparation:
 - 1) Clean the substrate so it is free of dust, dirt, grease, and other foreign substances that would impair with the bond of the primer coating material.



- 2) At a minimum, prepare the substrate surface in accordance with the Commercial Blast Cleaning requirements specified in SSPC-SP 6/NACE No. 3.
- 3) Prior to applying the primer coating, grind weld spatter and other defects smooth.
- b. Primer Application:
 - 1) Shop-apply the approved primer coating to properly cleaned substrate at the steel fabricators shop in accordance with the primer manufacturer's documented application instructions and with the provisions specified in Section 05120, Structural Steel.
 - a) Provide primer cut back areas a minimum of 3 inches (76mm) from bolted connections, and a minimum of 12 inches (305mm) from welded connections.
 - b) Submit the primer coating manufacturer's documented application instructions to the Program/Project Manager for information.
- c. Finish Standard:
 - 1) Provide a spray applied and back rolled application of intumescent paint product. Troweled application of material is acceptable where additional material is required to fill pits and voids to maintain required material thickness. Entire surface is to be sanded with consecutively finer grit papers, with the final sand using 120 grit papers or finer. Finished surface is to be a high decorative finish such that all pitting, orange peel or other texture is completely removed and all visible portions of the painted member are uniformly smooth. Match existing Terminal 4 Station Intumescent/High Performance Coating finished columns and approved mock-up for Stage 1A Terminal 3 Station. In matching the Terminal 4 Station columns, note that the high performance coating produced added texture on the finished columns, which will not be acceptable in the intumescent paint finish. Stage 2, 24th Street Station and Rental Car Center Station Intumescent/ High Performance Coating finished columns to be coordinated with the Architect, as per the approved mock-up.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that substrate and workspace temperature and humidity conditions are in accordance with requirements of this Section.
 2. Verify that all clip hangers, piping, ducts, equipment, and other items which would interfere with application of the fireproofing are not positioned or installed until the fireproofing application is complete.



3. All surfaces to receive intumescent fireproofing material must be clean, dry and free of oil, grease, loose mill scale, dirt, dust, and other foreign substances which would impair bond of the intumescent fireproofing material to the substrate.

B. Evaluation and Assessment:

1. Do not begin to apply the intumescent fireproofing until the Contractor's applicator and Program/Project Manager have examined the surfaces to receive this coating, and determined the surfaces are acceptable to receive the intumescent fireproofing material.
2. Beginning application will be construed as acceptance of the substrate by the Contractor.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from the over spray of fireproofing material.
 - a. Furnish masking, drop cloths, and/or other suitable coverings to prevent overspray onto surfaces not intended to be affected by Work in this Section.

B. Surface Preparation:

1. Where cleaning and other corrections of the surfaces to receive the intumescent fireproofing are necessary, this Work is the responsibility of the installer of the incompatible substrate.
2. Clean the substrate so it is free of dust, dirt, grease, and other foreign substances that would impair with the bond of the intumescent fireproofing material.
3. At a minimum, prepare the substrate surface in accordance with the Commercial Blast Cleaning requirements specified in SSPC-SP 6/NACE No. 3.

C. Demolition/Removal:

1. Prior to applying the fireproofing material, grind weld spatter and other defects smooth.

3.03 APPLICATION

A. Application Equipment and Procedures:

1. Application equipment and procedures must comply with the intumescent fireproofing manufacturer's requirements and application instructions.
 - a. Submit intumescent fireproofing manufacturer's written requirements and application instructions to the Program/Project Manager for information.
 - b. Apply intumescent fireproofing material only to primed surfaces in accordance with the manufacturer's application instructions.



2. Apply the tie coat in accordance with the tie coat manufacturer's documented application instructions.
3. Apply the fireproofing material to the required dry film thickness in accordance with the appropriate UL design listing.
 - a. Apply the intumescent fireproofing material to a maximum wet film thickness (WFT) of 250 mils per coat.
 - b. Apply subsequent coats until the final dry film thickness (DFT) is achieved for the required fire resistance rating.
4. Prior to applying the decorative top coat, complete the final texturing and finishing of the intumescent fireproofing surface in accordance with the intumescent fireproofing manufacturer's requirements.
5. Apply the decorative top coat in accordance with the top coat manufacturer's documented application instructions.
 - a. The final color, gloss, and finish will be determined and approved by the Program/Project Manager.
 - b. Submit the top coat manufacturer's documented application instructions to the Program/Project Manager for information.

3.04 REPAIR/RESTORATION

- A. Patch and repair intumescent fireproofing material damaged by other trades.
 1. The patching must be performed by applicators certified by the intumescent fireproofing manufacturer, and must be applied in accordance with the manufacturer's application instructions.
- B. Touch-up, repair, or replace damaged products before the date of Substantial Completion.

3.05 SITE QUALITY CONTROL

- A. During the period when intumescent fireproofing material is being applied, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 1. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 2. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 3. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.



B. Site Tests and Inspections:

1. Material Characterization Test:

a. Test Procedure:

- 1) Prior to mixing Component A and Component B of the intumescent fireproofing material together in preparation for application of the material, submit random, pre-determined liquid samples of Component A and Component B to the Program/Project Manager for material characterization (fingerprinting) in accordance with the procedures detailed in the ISO 20340.
- a) The Sample frequency will be pre-determined by the Program/Project Manager, and testing will be performed by an independent Testing and Inspection Agency employed by the Owner.

b. Acceptance Criteria:

- 1) Samples complying with the performance requirements of ISO 20340 will pass the Material Characterization Test.
- 2) The test results will be made available to all parties at the completion of testing for each pre-designated area, and must be approved prior to the application of the top-coat.

2. Inspections:

- a. The application of the intumescent fireproofing material will be inspected and verified in accordance with the provisions of AWC1 Technical Manual 12-B.
 - 1) The final dry film thickness (DFT) will be measured using a dry film thickness gauge.
- b. Prior to application of the decorative top coat, an intumescent fireproofing material inspection will be performed.

C. Non-Conforming Work

1. In-place intumescent fireproofing not in compliance with the specified requirements must be corrected prior to the application of the decorative top coat.

3.06 CLEANING

A. Remove intumescent fireproofing materials from surfaces not required to be fireproofed.

B. Waste Management:

1. After completing application of the intumescent fireproofing system, clear and remove all excess material, overspray, and debris from the Site.
2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.07 PROTECTION

- A. Protect applied intumescent fireproofing products until completion of the Contract.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 09980

Specifications Required for
Station Finishes

RFI
0313

COATINGS FOR CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following coatings for concrete and masonry:
 - a. Sealers/densifiers for interior concrete and masonry surfaces.
 - b. Surface hardeners for exterior concrete and masonry surfaces.
 - c. Floor coating and cove base for interior concrete and masonry surfaces.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. MSDS: Material Safety Data Sheets.
 - 2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. pH: A measure of the acidity or basicity of a solution, and defined as the cologarithm of the activity of dissolved hydrogen ions (H^+).
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 3. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
 - 4. United States Government:
 - a. Environmental Protection Agency (EPA):



- 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:

1. Interior Cementitious Substrates:

- a. Verify that new cementitious surfaces have aged at least 30 days, and that they have a pH below 10 before applying the sealer/densifier coating.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Interior concrete and masonry sealer/densifier.
- 2) Exterior concrete and masonry surface hardener.

b. Qualification Statements:

- 1) Exterior concrete and masonry surface hardener applicator's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Manufacturer's Instructions:

- 1) Concrete and masonry coating manufacturer's written application instructions.

2. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01360, Sustainable Design Requirements.

a. Paints and Coatings

- 1) Submit product data highlighting the VOC content for any field applied coating within the building's weather barrier.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Operation and Maintenance Data:

- 1) Written instructions detailing the recommended periodic maintenance for each type of concrete and masonry coating.

b. Warranty Documentation:

- 1) Concrete and Masonry Coating Materials Warranties.
- 2) Concrete and Masonry Coating Installation Warranties.



1.05 QUALITY ASSURANCE

A. Qualifications:

1. Exterior Concrete and Masonry Surface Hardener Applicator's Qualifications:
 - a. Employ an authorized applicator or licensed field service specialist having the necessary experience and technical capability to apply the concrete and masonry surface hardener.
 - b. Submit the exterior concrete and masonry surface hardener applicator's qualifications to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver material to the Site in unopened containers clearly labeled by the manufacturer with the trade name, type, grade, shelf life, and other identifying data.

B. Storage and Handling Requirements:

1. Store materials in air tight containers protected from the weather.
2. Discard materials that have exceeded their shelf life without use.

C. Packaging Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Interior Concrete and Masonry Sealer/Densifier:
 - a. Do not apply interior concrete and masonry sealer/densifier when the indoor or surface temperatures are below 55 degrees Fahrenheit.
 - b. Do not apply interior concrete and masonry sealer/densifier where it will be immersed in water, such as a fountain, pool, or below grade area.
2. Exterior Concrete and Masonry Surface Hardener:
 - a. Avoid application during cool, humid conditions.

1.08 WARRANTY

A. Manufacturer Warranty:

1. Warrant the concrete and masonry coatings against defects in materials within the 1-year period after the Date of Substantial Completion:
 - a. The manufacturer's liability does not include variable factors out of the manufacturer's control, such as environmental conditions, application



techniques, and surface conditions which are critical to the results obtained.

- b. Submit a Concrete and Masonry Coating Materials Warranty on the concrete and masonry coating manufacturer's standard or customized form, without monetary limitation, in which the concrete and masonry coating manufacturer agrees to replace properly applied concrete and masonry coatings that fail in materials within the specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.

B. Special Warranty:

1. Installer's Warranty:

- a. Warrant the concrete and masonry coatings workmanship against failures within the 3-year period after the Date of Substantial Completion:
 - 1) Submit a Concrete and Masonry Coating Installation Warranty on the installer's standard or customized form, without monetary limitation, in which installer agrees to repair concrete and masonry coatings that fail within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 CONCRETE AND MASONRY COATING SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Field-Applied Interior Paints and Coatings:



- 1) Provide paint products having volatile organic compound content, exclusive of colorants added to a tint base, not greater than the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59:
 - a) Concrete curing compounds: Not more than 100 g/L
 - b) Floor coatings: Not more than 50 g/L
- 2) Refer to Section 01360 of this specification for a complete list of VOC limits for this project.

C. Performance:

1. Interior Concrete and Masonry Sealer/Densifier:
 - a. Provide a sealer/densifier exhibiting the following qualities:
 - 1) Low odor.
 - 2) Slip and scuff resistant.
 - 3) Suitable for use on porous interior tile or masonry surfaces where oil and water repellency are desired.
 - 4) Seals in the outgassing from the substrate.
2. Exterior Concrete and Masonry Surface Hardener:
 - a. Provide an exterior surface hardener that forms an insoluble permanent bond with concrete surfaces; that is resistant to ultraviolet radiation, stains, strong cleaning compounds, alkalis, solvents, oils, and many acids; and that does not support mildew or fungi growth.
3. Material Compatibility:
 - a. Materials for use within each paint/coating system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - b. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
 - c. Products shall be of same manufacturer for each coat in a coating system.

D. Design Criteria:

1. Product Data:
 - a. Obtain the manufacturer's Product Data for the concrete and masonry coatings.
 - b. Submit the Product Data for the concrete and masonry coatings to the Program/Project Manager for approval.

E. Materials:

1. Interior Concrete and Masonry Sealer/Densifier:
 - a. Provide a water-based, medium gloss, clear acrylic polymer emulsion sealer/densifier that contains no formaldehyde.
 - b. Manufacturers:



- 1) American Formulation and Manufacturing (AFM), Safecoat MexeSeal, www.info@afmsafecoat.com.
- 2) Approved equal.
2. Exterior Concrete and Masonry Surface Hardener:
 - a. Provide a micro film forming hybrid inorganic/organic exterior surface hardening and protective clear coat suitable for application on exterior concrete and masonry surfaces.
 - b. Thickness:
 - 1) Provide an exterior surface hardener that forms a 2-mil to 3-mil protective surface film.
 - 2) Provide an exterior surface hardener that penetrates the surface to a depth of between 2mm and 8mm.
 - c. Curing:
 - 1) Provide a rapid curing exterior surface hardener that is dry to the touch 30 to 60 minutes after application.
 - d. Manufacturers:
 - 1) Convergent Group S.A., Pentra-Guard™ (EXT), <http://www.convergent-group.com/homepage.html>.
 - 2) Approved equal.
3. Interior Concrete and Masonry Floor Coating and cove base:
 - a. Provide an Epoxy Non-Slip Deck Coating System MPI EXT 3.2C.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: Epoxy deck coating (slip resistant), MPI #82
 - a) Sherwin-Williams Company; www.sherwin-williams.com

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the concrete and masonry coating applicator present, examine the substrates for conditions that would affect the performance of the applied concrete and masonry coatings.
- B. Pre-Installation Testing:
 1. Interior Concrete and Masonry Sealer/Densifier:
 - a. Test the surface porosity and profile by dropping water onto the dry surface.
 - 1) If the water drops fail to penetrate quickly, the surface may need additional remediation to create the proper surface profile.
 2. Exterior Concrete and Masonry Surface Hardener:
 - a. Test each concrete surface for its suitability and to verify that the desired results will be obtained.



C. Evaluation and Assessment:

1. Report unsatisfactory conditions to the Program/Project Manager in writing.
2. Proceed to apply the concrete and masonry coatings only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Mask off and otherwise protect adjacent areas from splatters, splashes, and overspray.

B. Surface Preparation:

1. Interior Concrete and Masonry Sealer/Densifier:

- a. All surfaces to receive the sealer/densifier must be clean, sound, dry, and free of any dirt, dust, oil, wax, grease, mildew, mold, and other contaminants and debris.
 - 1) Remove loose or peeling paint, and scuff sand the surface to create the proper surface profile.
 - 2) Remove all mildew prior to applying the coating.
 - 3) Scrub the surface with a product and solution mix recommended by the sealer/densifier manufacturer.
 - a) Triple rinse the surface to ensure that the cleaner has been completely removed.
 - 4) Test for surface cleanliness by applying a strong tape, such as duct tape, to the cleaned areas and pull it back up.
 - a) If the tape is free of any concrete dust or dirt, the surface is clean.
 - b) If particles or a white residue are still present, remove them completely with additional scrubbing, rinsing, and possibly etching.
- b. For the best adhesion on smooth surfaces with no surface profile, acid-etching may be required, followed by completely neutralizing the surface.
 - 1) Use extreme caution when working with acid, and comply with the requirements on the label and with Material Safety Data Sheet (MSDS) precautions.
 - 2) Remove all acid residual prior to applying the coating.
 - 3) The surface must have a pH between 7 and 10 for the best results.

2. Exterior Concrete and Masonry Surface Hardener:

- a. Prior to applying the exterior surface hardener, fill cracks and repair honeycombed and structurally unsound surfaces.
- b. Thoroughly clean the substrates to receive the surface hardener with a black (light abrasive) scrubbing pad and a neutral pH detergent to remove membrane forming compounds, sealers, oil, grease, dirt, dust, drywall residue, and other contaminants.



- 1) The substrate may be sanded using a 60-grit to 100-grit sanding screen or diamond abrasive pad.
- a) Remove dust and residue using a riding or walk-behind scrubber with water or broom, and then rinse and squeegee the surface until it is dry.

3.03 APPLICATION

- A. Apply the concrete and masonry coatings in accordance with the coating manufacturer's application instructions.
 1. Coverage:
 - a. Apply the material at the coverage rate recommended by the manufacturer.
 2. Submit the concrete and masonry coating manufacturer's written application instructions to the Program/Project Manager for information.
- B. Interior Concrete and Masonry Sealer/Densifier:
 1. Prior to applying the interior concrete and masonry sealer/densifier, stir the material thoroughly but gently without excessive agitation so air bubbles are avoided.
 - a. Do not be reduce the material.
 2. Apply the interior concrete and masonry sealer/densifier using a squeegee brush, roller, sponge, or appropriate spray equipment in thin coats.
 - a. Apply the sealer/densifier only to a completely dry substrate.
 - b. Two or more coats may be needed depending on porosity of concrete or masonry.
 3. Drying/Curing:
 - a. To facilitate quick drying/curing, furnish adequate ventilation and air flow to the work area.
 - b. Normal drying/curing conditions require a clean, dry surface, access to a fresh air flow, a dust free environment, moderate humidity, and temperatures above 55 degrees Fahrenheit.
 - c. Allow at least 2 hours for drying between coats.
 - 1) Thick applications, high humidity, or conditions other than normal will cause the sealer/densifier to dry and cure more slowly.
- C. Exterior Concrete and Masonry Surface Hardener:
 1. Before applying the surface hardener to the substrates, thoroughly agitate it by mixing, shaking, or stirring.
 2. Do not apply the exterior concrete and masonry surface hardener to non-porous surfaces.
 3. Spray-apply the surface hardener to the substrates, and immediately distribute pooling material using a soft broom.
 4. Where a second coat is required to achieve the specified results, allow 60 minutes after applying the first coat before applying the second coat.



D. Special Techniques:

1. To enhance slip and stain resistance, burnish the completed sealed exterior concrete or masonry surface area using a 400-grit pad using equipment its own dust collection system.

3.04 CLEANING

A. Interior Concrete and Masonry Sealer/Densifier:

1. Periodically mop the protected floors with clean water or an odorless, dye-free, non-volatile all purpose cleaner.
2. The protected floors may be scrubbed with a white pad and a floor machine operating at 175 revolutions per minute before recoating.

B. Exterior Concrete and Masonry Surface Hardener:

1. Sweep, mop, wash, and mechanically scrub the protected floors with water and neutral pH cleaners.
2. Do not sand or polish the protected floors.

C. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

A. Interior Concrete and Masonry Sealer/Densifier:

1. Do not allow any traffic on the protected surfaces for 8 hours to 24 hours after application of the sealer/densifier, depending on conditions.

B. Exterior Concrete and Masonry Surface Hardener:

1. Protect the curing surface hardener from standing water.
2. Do not allow any traffic on the protected surfaces for 60 minutes after application of the surface hardener.
3. Light pedestrian traffic is allowed on the protected surfaces 60 minutes after application of the surface hardener.
4. Vehicular traffic is allowed on the protected surfaces 2 hours after application of the surface hardener.

3.06 MAINTENANCE

A. Maintenance Data:

1. Submit written instructions detailing the recommended periodic maintenance for each type of concrete and masonry coating to the Program/Project Manager.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	08/14/2018	N/A	1.01.A.1.c., 2.01.C.3, 2.01.E.3.	Clarified epoxy coating information.



SECTION 10200

LOUVERS AND VENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for stationary wall louvers.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07920 - Joint Sealants.
 - 5. Section 09960 - High-Performance Coatings.
 - 6. Section 09961 - Fluoropolymer Coatings.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. DFT: Dry film thickness.
 - 2. w. g.: Water gauge.
- B. Definitions:
 - 1. NBS Unit: Short for the National Bureau of Standards (NBS) Unit of Color Difference, a unit to describe the size of the difference, ΔE , between 2 colors of tristimulus specifications based on Equation 13 in the now obsolete NBS Circular C429, Photoelectric Tristimulus Colorimetry with Three Filters.
- C. Reference Standards:
 - 1. Aluminum Association (AA):
 - a. AA DAF-45 – Designation System for Aluminum Finishes.
 - 2. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
 - 3. Air Movement and Control Association International, Inc. (AMCA):
 - a. AMCA 11 – Certified Ratings Program Operating Manual.
 - b. ANSI/AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.
 - c. AMCA 511 - Certified Ratings Program – Product Rating Manual for Air Control Devices.
 - 4. ASTM International (ASTM):
 - a. ASTM B 209 - Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.



- b. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- c. ASTM D 822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- d. ASTM D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- e. ASTM D 4214 - Standard Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Product Data:
 - 1) Drainable louvers.
 - 2) Non-drainable sight-proof louvers.
 - 3) Blank-off panels.
 - 4) Hinged frames.
 - 5) Security bars.
 - 6) Filter racks.
 - 7) Bird screens.
 - 8) Insect screens.
 - 9) Extended sills.
 - 10) Visible mullions.
- b. Shop Drawings:
 - 1) Louvers and vents.
- c. Samples:
 - 1) Samples of each style of louver.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Manufacturer's Instructions:
 - 1) Louver and vent manufacturers' written installation instructions.

C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Louver and Vent Manufacturer's Warranty.
 - 2) Louver and Vent Finish Warranty.

1.04 QUALITY ASSURANCE

- A. Certifications:
 1. Air Movement and Control Association International, Inc. (AMCA)
Licensed Products:
 - a. Louvers and Vents:
 - 1) Provide only louvers and vents that have been licensed to bear the AMCA air performance and water penetration seals by having participated in the AMCA Certified Ratings Program.
 - a) Comply with the procedures and testing requirements for performance rating louvers and vents specified in AMCA 11, AMCA 511, and ANSI/AMCA 500-L.
 - b) Provide only louvers labeled with the AMCA air performance and water penetration Certified Ratings Seals.
- B. Site Samples:
 1. Submit Samples of each style of louver to show the frame, blades, bird screen, gutters, downspouts, vertical supports, sill, accessories, finish, and color to the Program/Project Manager for approval.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials to site in the manufacturer's original, unopened containers and packaging, with labels clearly indicating the manufacturer and material.
- B. Storage and Handling Requirements:
 1. Store materials in a dry area indoors, protected from damage and in accordance with the manufacturer's instructions.
 - a. Store the products in the manufacturer's unopened packaging until it is time to install the products.
 2. During handling and installation, protect materials and finishes so damage is prevented.
 3. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with the requirements of the local Authorities Having Jurisdiction.
- C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.06 SITE CONDITIONS

A. Ambient Conditions:

1. Do not install louvers and vents when the ambient temperature, humidity, and ventilation are not within the environmental limits recommended by the manufacturer for optimum results.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Warrant the louver and vent materials and workmanship against failures within the 1 year period after the Date of Substantial Completion.
2. No more than 18 months after shipment of the louver and vent materials from manufacturing plant, submit the Louver and Vent Manufacturer's Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured louvers and vents that fail in materials or workmanship within specified warranty period to the Program/Project Manager.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.
 - b. When notified in writing of a manufacturing defect in louver and/or vent materials by the Owner, have the manufacturer promptly correct the deficiencies at no increase in Contract Price.

B. Special Warranty:

1. Warrant the fluoropolymer-based finish on extruded aluminum substrates of louvers and vents against the following defects within the 20 year period after the Date of Substantial Completion:
 - a. Peeling, blistering, chipping, cracking, or checking of the finish coating.
 - b. Chalking of the finish coating in excess of 8 numerical ratings when measured in accordance with the methods specified in ASTM D 4214.
 - c. Changes in color or fading of the finish coating in excess of 5 NBS units as determined in accordance with the methods specified in ASTM D 822 and ASTM D 2244.
 - d. Erosion of the finish coating in excess of at a rate in excess of 0.01 mils per year as determined by a Florida test sample.
2. Submit the Louver and Vent Finish Warranty to the Program/Project Manager.



PART 2 PRODUCTS

2.01 LOUVER AND VENT ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Performance and design data presented herein is based on testing a 48 inches by 48 inches (1219mm by 1219mm) size unit in accordance with the methods specified in ANSI/AMCA 500-L.
 - 2. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Pressure Drop:
 - a. Provide drainable louvers having a maximum pressure drop of 0.15 inches w. g. (3.8mm w. g.).
 - b. Provide non-drainable sight-proof louvers having a maximum pressure drop (intake) of 0.10 inches w. g. (0.03kPa).
 - 2. Water Penetration:
 - a. Provide drainable louvers having a maximum water penetration of 0.01 ounces per square foot (3.1g/m²) of free area at an air flow of 1,023 feet per minute (312m/min) free area velocity when tested for 15 minutes.
 - b. Provide non-drainable sight-proof louvers having a maximum water penetration of 0.01 ounces per square foot (3.1g/m²) of free area at an air flow of 660 feet per minute (201m/min) free area velocity when tested for 15 minutes.
- D. Design Criteria:
 - 1. Design Loads:
 - a. Wind Loads:
 - 1) Unless more stringent requirements are specified in the applicable Codes, incorporate structural supports in the louvers and vents



- designed to withstand a wind load of 20 pounds per square foot (0.96kPa).
- b. Seismic Loads:
 - 1) Factory-engineer the louvers and vents to withstand the seismic loads specified in ASCE/SEI 7, or local requirements of Authority Having Jurisdiction, whichever is more stringent.
 - 2. Free Area:
 - a. Provide drainable louvers designed to have a nominal free area of 57 percent.
 - 1) Provide drainable louvers having a free area size of 9.08 square feet (0.84m²).
 - b. Provide non-drainable sight-proof louvers designed to have a nominal free area of 56 percent.
 - 3. Air Flow through Free Area:
 - a. Provide drainable louvers designed to have a maximum recommended air flow through the free area of 1,023 feet per minute (312m/min).
 - 1) Provide drainable louvers designed to have an air flow of 9289 cubic feet per minute (263m³/min).
 - b. Provide non-drainable sight-proof louvers designed to have a maximum recommended air flow through the free area of 660 feet per minute (201m/min).
 - 1) Provide non-drainable sight-proof louvers designed to have an air flow of 5887 cubic feet per minute (167m³/min).
 - 4. Product Data:
 - a. Obtain Product Data for each product proposed for the Work of this Section, including the following information:
 - 1) Performance data.
 - 2) Instructions and recommendations for preparation, and installation methods.
 - 3) Storage and handling requirements and recommendations.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 5. Shop Drawings:
 - a. Prepare Shop Drawings for the louvers and vents that indicate the louver and vent materials, construction, dimensions, accessories, and installation details.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- E. Materials:
- 1. Drainable Louvers:
 - a. Provide stationary drainable louvers fabricated from extruded aluminum Alloy 6063-T5.
 - b. Frames:



- 1) Provide aluminum frames having a 0.081 inch (2.1mm) nominal material wall thickness, and a louver depth of 6 inches (152mm).
 - 2) Provide downspouts and caulking surfaces in the frames.
- c. Blades:
 - 1) Provide aluminum blades having a 0.081 inch (2.1mm) nominal material wall thickness, a blade angle of 37.5 degrees, and spaced approximately 5-29/32 inches apart on center.
- d. Bird Screen:
 - 1) Provide bird screens fabricated from expanded, flattened $\frac{3}{4}$ inch by 0.051 inch (9mm x 1.3mm) aluminum bars, a $\frac{1}{2}$ inch (13mm) mesh of 0.063 (1.6mm) intercrimped aluminum in a removable, rewirable frame.
- e. Drainage:
 - 1) Provide a drain gutter in each head frame and in each blade, and provide downspouts in the jambs designed to drain water from the louver and minimize water cascading from blade to blade.
- f. Vertical Supports:
 - 1) Provide hidden vertical supports that allow the appearance of a continuous line up to 120 inches (3048mm) long.
- g. Sills:
 - 1) Provide a steeply angled integral sill for each louver or vent that eliminates areas of standing or trapped moisture where mold or mildew could thrive and effect indoor air quality.
- h. Manufacturers:
 - 1) Ruskin Manufacturing, Model ELF6375DX, <http://www.ruskin.com>.
 - 2) Construction Specialties, Model A6177, <http://www.c-sgroup.com>
 - 3) Approved equal.
2. Non-Drainable Sight-Proof Louvers:
 - a. Provide stationary non-drainable sight-proof continuous blade louvers fabricated from extruded aluminum Alloy 6063-T5.
 - 1) Provide mullion style louvers having visible mullions or frames at the perimeter of the louver and also at certain intervals within the louver perimeter to support the louver blades.
 - a) Louver blade sightlines may be interrupted at the mullion locations.
 - 2) Do not use rear-mounted blade supports.
 - b. Frames:
 - 1) Provide aluminum frames having a 0.081 inch (2.1mm) nominal material wall thickness, and a louver depth of 3 inches (76mm).
 - c. Blades:
 - 1) Provide formed aluminum Alloy 6063-T5 horizontal chevron style blades having a 0.081 inch (2.1mm) nominal material wall thickness, a blade angle of 45 degrees, and spaced approximately 1-7/16 inches (36mm) apart on center.
 - d. Manufacturers:



- 1) Ruskin Manufacturing, Model ELF30V, <http://www.ruskin.com>.
- 2) Approved equal.

F. Shop Fabrication:

1. Factory-assemble the stationary drainable louvers by welding all louver components together.
2. Factory-assembled stationary non-drainable sight-proof louvers by mechanically fastening the louver components together.

G. Finishes:

1. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes in AA DAF-45.
2. Primer Materials:
 - a. For field finished surfaces, provide alkyd, epoxy, vinyl, urethane, or other heavy-duty primer materials compatible with the topcoats.
 - b. For shop-finished surfaces, provide the manufacturers recommended primer materials compatible with the topcoats.
3. Finish Materials:
 - a. Fluoropolymer Coatings:
 - 1) Provide a fluoropolymer coating system complying with the requirements specified for a 3-coat system specified in Section 09961, Fluoropolymer Coatings.
 - 2) Color for Fluoropolymer Coating:
 - a) Unless custom fluoropolymer coating colors are indicated on the Contract Drawings, provide colors as selected by the Program/Project Manager from the manufacturers standard paint system specified.
 - b. Anodized Finishes:
 - 1) Class 1 Clear Anodized Finish.
 - a) Chemically etch and pretreat the substrate to be anodized in accordance with the requirements specified for an AA-C22A31 finish.
 - b) Following the chemical etching and pretreatment, apply a 204-R1 clear anodize finish having at a minimum a 0.4 mil (0.01mm), thickness after a 30 minute anodizing process.
 - 2) Class 2 Clear Anodized Finish:
 - a) Chemically etch and pretreat the substrate to be anodized in accordance with the requirements specified for an AA-C22A41 finish.
 - b) Following the chemical etching and pretreatment, apply a 215-R1 clear anodize finish having at a minimum a 0.7 mil (0.018mm), thickness after a 60 minute anodizing process.
 - 3) Class 1 Color Anodized Finish:



- a) Chemically etch and pretreat the substrate to be anodized in accordance with the requirements specified for an AA-C22A44 finish.
 - b) Following the chemical etching and pretreatment, apply one of the following color anodize finishes as indicated on the Contract Drawings; and having, at a minimum, a 0.7 mil (0.018mm) thickness after a 60 minute anodizing process.
 - (1) Champagne.
 - (2) Light Bronze.
 - (3) Medium Bronze.
 - (4) Dark Bronze.
 - (5) Black.
- 4. Shop Finishing Methods:
 - a. Provide louvers and vents having a standard mill finish.
 - b. For louvers to be painted in the field, apply an alkyd primer in the shop.
 - a. Fluoropolymer Coatings:
 - 1) For louvers to receive a fluoropolymer coating or modified fluoropolymer coating, apply the finish to the louvers and vents in the shop:
 - a) Chemically clean and pre-treat the louvers in accordance with the requirements specified for the AA-C12C42R1X finish in AA DAF-45.
 - b) Following chemical cleaning and pretreatment, apply an alkyd prime coat the louvers in preparation for field painting.
 - c) Dry the louvers before applying the final finish.
 - d) Provide fluoropolymer coatings complying with the requirements specified in AAMA 2605, and modified fluoropolymer coatings complying with the requirements specified in AAMA 2604.
 - e) Total Dry Film Thickness:
 - (1) Apply the coating so the approximate total dry film thickness (DFT) is 1.2 mils (0.03mm) after the coating is baked at 450 degrees Fahrenheit (232 degrees Celsius) for 10 minutes.
 - b. Apply a Class 1 clear anodized finish.
 - c. Apply a Class 1 color anodized finish.

2.02 ACCESSORIES

- A. Blank-Off Panels:
 - 1. Insulated Blank-Off Panels:
 - a. Provide insulated aluminum blank-off panels having a 1 inch (25mm) insulation core, factory-installed with removable screws and neoprene gaskets, in an aluminum skin.
 - 2. Un-Insulated Blank-Off Panels:



- a. Provide aluminum blank-off panels fabricated from 0.040 inch (1mm) aluminum sheet.
- B. Hinged Frames:
 - 1. Provide a continuous piano hinge attached to an angle or channel subframe.
- C. Security Bars:
 - 1. Front Security Bars:
 - a. Provide front security bars fabricated from 3/4 inch by 1/2 inch (19mm by 13mm) aluminum bar stock.
 - 2. Rear Security Bars:
 - a. Provide rear security bars fabricated from 1/2 inch by 1/2 inch (13mm by 13mm) galvanized steel, 3/4 inch by 1/2 inch (19mm by 13mm) galvanized steel, 3/4 inch by 1/2 inch (19mm by 13mm) aluminum bar stock.
- D. Filter Racks:
 - 1. Provide formed aluminum channel filter racks designed to accept standard [1 inch (25 mm)][2 inch (51 mm)] thick filters.
 - 2. Blank off the unused bottom portions of the racks using 0.040 inch (1mm) aluminum sheet.
- E. Bird Screens:
 - 1. Provide bird screens fabricated from 3/4 inch by 0.051 inch (19mm by 1.3mm) expanded, flattened aluminum assembled in removable, rewirable frames.
 - 1. Provide bird screens fabricated from 0.063 inch (1.6mm) aluminum inter-crimped into a 1/2 inch (13mm) mesh assembled in removable, rewirable frames.
- F. Insect Screens:
 - 1. Provide fine mesh insect screens.
- G. Extended Sills:
 - 1. Provide extended sills fabricated from extruded aluminum Alloy 6063-T5 having a minimum nominal wall thickness of 0.060 inch (1.5mm), 0.081 inch (2.1mm).
- H. Visible Mullions:
 - 1. Where indicated on the Contract Drawings for an architectural accent, provide the manufacturer's standard horizontal or vertical visible mullions.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Inspect the areas to receive louvers.
 - 2. Verify that the preparation of openings to receive the louvers is satisfactory.
- B. Evaluation and Assessment:
 - 1. Notify the Program/Project Manager of conditions that would adversely affect the installation or subsequent utilization of the louvers.
 - 2. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the louvers and vents.
- B. Surface Preparation:
 - 1. Clean the openings to receive louvers thoroughly prior to installing the louvers.
 - 2. Prepare surfaces using the methods recommended by the manufacturer for the substrate to achieve the best result under the prevailing conditions.

3.03 INSTALLATION

- A. Install louvers and vents at the locations indicated on the Contract Drawings and in accordance with the manufacturer's installation instructions.
 - 1. Submit the louver and vent manufacturers' written installation instructions to the Program/Project Manager for information.
- B. Install the louvers plumb, level, in the plane of the wall, and in alignment with adjacent work.
- C. Install joint sealants in accordance with the requirements specified in Section 07920, Joint Sealants.
- D. If a louver is to be painted in the field, within 6 months of the application of the shop prime coat apply its topcoat in accordance with the requirements specified in Section 09960, High-Performance Coatings.

3.04 REPAIR

- A. Repair minor damaged surfaces as directed by the Program/Project Manager.



- B. Touch-up, repair, or replace damaged products before Substantial Completion.

3.05 CLEANING

- A. Clean the louver surfaces in accordance with the manufacturer's instructions.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Provide protection and maintain conditions, in a manner acceptable to the louver and vent manufacturer, that ensure the louver and vent units are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 10290

PEST CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for pest controls, including bird-net netting, bird netting hardware, and a surface cleaning system, at the locations indicated in the Contract Documents.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 02361 - Termite Control.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. HDPE: High density polyethylene.
 - 2. PPE: Personal protection equipment.
 - 3. UV: Ultraviolet.
- B. Reference Standards:
 - 1. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Bird netting.
 - 2) Bird netting hardware.
 - 3) Surface cleaning system.
 - b. Shop Drawings:
 - 1) Pest control systems.
 - c. Samples:
 - 1) Bird netting.
- B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Pest control manufacturer's installation and application guidelines.

C. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Tools:
 - 1) Furnish a setting tool for the machine screw anchors.
 - 2) Furnish a driver socket for installing the sidewinders.

1.04 QUALITY ASSURANCE

A. Site Samples:

1. Bird Netting:
 - a. Submit a Sample of the bird netting proposed for the Work of this Section that is at least 6 inches (152mm) square to the Program/Project Manager for approval.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver the pest control materials in their original unopened packages, containers, or bundles bearing the brand name and identification of the manufacturer or Supplier.
 - a. Include Material Safety Data Sheets for the surface disinfectants and deodorizers that indicate proper handling and disposal methods for each material.

B. Storage and Handling Requirements:

1. Store the netting and netting hardware shipping boxes so they will be kept dry, clean, and undamaged.
2. Do not stack or place other packaging or objects on the bird netting shipping boxes.
3. Keep bird-net bird netting, installation hardware and surface cleaning systems in their original packaging until the time they are installed.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



PART 2 PRODUCTS

2.01 PEST CONTROL SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. ABC Advanced Bird Control, Division of Nixalite of America, Inc., <http://www.abcbirdcontrol.com>.
 - b. Bird-X, <http://www.bird-x.com>.
 - c. Approved equal.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. This Section provides pest controls consisting of bird netting capable of keeping out a wide variety of pest birds, bats, and most critters and larger rodents.
 - 2. For termite control, comply with the requirements specified in Section 02361, Termite Control.
 - 3. Regulatory Requirements:
 - a. Comply with all local, State, and Federal regulations regarding the proper removal and disposal of bird droppings.
- C. Performance:
 - 1. Bird Netting:
 - a. Provide bird netting capable of keeping out a wide variety of pest birds, bats, and most critters and larger rodents.
- D. Design Criteria:
 - 1. Bird Netting:
 - a. Contact the bird netting manufacturer and obtain up-to-date information and recommendations for bird netting hardware applications, item combinations, and new items and procedures that may be pertinent to the planning and procedures for, and installation of, the bird netting.
 - b. Mesh Sizes and Applications:
 - 1) For small and large pest birds, provide 3/4-inch (19mm) square mesh.
 - 2) For medium to large pest bird species, provide 1-1/8-inch (28mm) square mesh.
 - 3) For large bird species only, provide 2-inch (51mm) square mesh
 - 2. Bird Netting Hardware:



- a. Provide bird netting hardware as required for efficiently fastening the bird netting to the types of surface shapes and materials encountered during the performance of the Work of this Section.
 - 1) The hardware spacing determines the maximum net cable run lengths.
- b. Provide a hardware system, which may be a hybrid system that combines methods from different fastening procedures, that best suits the netting installation and Site conditions.
 - 1) Hardware combinations can be mixed to suit changing surface materials and conditions.
- c. Provide appropriate netting accessories to allow access behind the installed netting system.
- d. Cable Run Connections:
 - 1) Wire rope clamps are the recommended connection for all cable runs.
 - 2) Wire rope clamps are mandatory for connecting cable runs over 25 feet (7.6m).
- e. Maximum Hardware Spacing:
 - 1) Eyebolts:
 - a) Large Eyebolts:
 - (1) Space large eyebolts no more than 50 feet (15.2m) apart.
 - b) Small Eyebolts:
 - (1) Space small eyebolts no more than 24 inches (610mm) apart on center.
 - 2) Screw Eyes:
 - a) Large Screw Eyes:
 - (1) Space large screw eyes no more than 50 feet (15.2m) apart.
 - b) Small Screw Eyes:
 - (1) Space small screw eyes no more than 24 inches (610mm) apart on center.
 - 3) Cotter Pins and Anchors:
 - a) Space anchors with cotter pins no more than 24 inches (610mm) apart on center.
 - 4) Sidewinders:
 - a) Space sidewinders no more than 24 inches (610mm) apart on center.
 - 5) Clips:
 - a) Space clips no more than 12 inches (305mm) apart on center.
 - 6) Net Rings:
 - a) Provide the following numbers of net rings for each of the attachment applications indicated:
 - (1) Netting to Cable:
 - (a) For each size of netting mesh, provide 16 net rings per foot.



- (2) Lapped Seams:
 - (a) Provide 32 net rings per foot, but for each mesh ensure that 1 net ring is on each side of the seam.
 - (3) Zipper Installations:
 - (a) Provide 32 net rings per foot, but for each mesh ensure that 1 net ring is on each side of the zipper.
 - 7) Twist Locks:
 - a) Space twist locks no more than 3 inches (76mm) apart on center.
 - 3. Surface Cleaning System:
 - a. Provide surface disinfectants and deodorizers formulated to properly prepare the surface for installation and to neutralize potentially hazardous bird and/or animal wastes.
 - 4. Product Data:
 - a. Obtain Product Data for the pest controls, including the bird netting, bird netting hardware, and surface cleaning system manufacturers' specification literature and installation and application guidelines.
 - b. Submit the manufacturers' Product Data to the Program/Project Manager for approval.
 - 5. Shop Drawings:
 - a. Prepare Shop Drawings for the pest control systems detailing the scope of the bird netting enclosure, and the type, location, and spacing of the mounting hardware.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- E. Materials:
- 1. Bird-Net Bird Netting:
 - a. Provide seamless, knotted bird netting fabricated from abrasion-resistant, flame-resistant, rot-resistant, and UV radiation-resistant high density polyethylene (HDPE).
 - b. Thermal Properties:
 - 1) Provide bird netting having a melting point of at least 250 degrees Fahrenheit (145 degrees Celsius).
 - 2) Provide bird netting that will remain flexible at very low temperatures.
 - c. Physical Properties:
 - 1) Specific Gravity:
 - a) Provide bird netting having a specific gravity of 0.96.
 - 2) Water Absorption:
 - a) Provide waterproof bird netting that will not absorb water.
 - 3) Chemical Properties:
 - a) Provide bird netting that is chemically inert.
 - b) Provide bird netting that is resistant to acids and alkalis at room temperature.



- 4) Color:
 - a) Provide black or stone (tan) bird netting.
- 2. Bird Netting Hardware:
 - a. Tensioned Cable Hardware:
 - 1) Connection Hardware:
 - a) Net Cable:
 - (1) Provide aircraft grade, Type 302 or Type 304 stainless steel, 7x7 49-strand, 3/32 inch (2.2mm) diameter cable having a 900 pound (407kg) breaking strength.
 - b) Turnbuckles:
 - (1) Provide stainless steel hook and eye turnbuckles appropriately sized for the cable run lengths and safe working loads recommended by the manufacturer.
 - c) Cable Thimbles:
 - (1) Provide stainless steel cable thimbles designed for 3/32-inch (2.2mm) diameter cable, and designed to prevent cable fraying and creasing when the cable system is tensioned.
 - d) Ferrules:
 - (1) Provide zinc plated copper ferrules designed for 3/32-inch (2.2mm) cable, and capable of connecting cable runs up to 25 feet (7.6m).
 - (a) Provide 2 ferrules per connection.
 - (b) Provide cable thimbles for use in conjunction with ferrules.
 - e) Wire Rope Clamps:
 - (1) Provide galvanized or stainless steel wire rope clamps designed for 3/32-inch (2.2mm) diameter cable.
 - (a) Provide 2 wire rope clamps per connection.
 - (b) Provide cable thimbles for use in conjunction with wire rope clamps.
 - 2) Cable Anchoring Hardware:
 - a) Large Eyebolts:
 - (1) For steel, iron, and heavy gauge sheet metal substrates, provide extreme duty, stainless steel, large eyebolts.
 - (a) Provide 2-inch (51mm) long large eyebolts having a 9/16 inch (14.2mm) inside diameter and a 1/4-20 stainless steel hex nut.
 - b) Large Screw Eyes:
 - (1) For wood beams, heavy to medium gauge sheet metal, and wood core substrates, provide extreme duty, stainless steel, large screw eyes.
 - (a) Provide 2-inch (51mm) long eyebolts having a 17/32 inch (13.5mm) inside diameter.
 - c) Eyebolts and Machine Screw Anchors:



- (1) For concrete, stone, masonry block, brick, and pre-cast substrates, provide stainless steel eyebolts and machine screw anchors.
 - (a) Provide 2-inch (51mm) long eyebolts having a 9/16 inch (14.2mm) inside diameter and a 1/4-20 threads outside.
 - (2) Machine Screw Anchor:
 - (a) Provide 1/2-inch (12.7mm) diameter by 1 inch (25.4mm) deep zinc plated machine screw anchors having 1/4-20 threads inside.
- 3) Cable Guide Hardware:
 - a) Cotter Pins and Anchors:
 - (1) For concrete, masonry block, brick, and pre-cast substrates, provide cotter pin and nylon anchors.
 - (a) Provide 1/8 inch by 1 inch (3mm by 25.4mm) Type 302 stainless steel cotter pins.
 - (b) Provide 1/4-inch by 1 inch (6.3mm by 25.4mm) nylon expansion anchors.
 - b) Small Screw Eyes:
 - (1) For wood, medium/light gauge sheet metal, and wood core substrates, provide small, 1-3/16-inch (31mm) long heavy duty, stainless steel screw eyes having a 7/32-inch (5.3mm) inside diameter.
 - c) Small Eye Bolts:
 - (1) For steel, iron, and heavy gauge sheet metal substrates, provide small, heavy duty, stainless steel, 1-3/8-inch long eyebolts having a 9/32-inch (7.1mm) inside diameter:
 - d) Sidewinders:
 - (1) For heavy gauge sheet metal, structural steel up to 1/2 inch thick, and solid concrete substrates, provide sidewinders.
 - (a) For steel substrates, provide self-drilling, self-tapping sidewinders that do not require pilot holes.
 - (b) For concrete substrates, provide sidewinders that require pilot holes.
- 4) Finishing Hardware:
 - a) Net Rings:
 - (1) Provide stainless steel net rings designed for installation using either a manual ring tool or a pneumatic ring tool.
 - b) Net Zippers:
 - (1) Provide black heavy duty, marine-grade, net zippers consisting of a 3/4-inch (19mm) fabric tape, an open top, and an automatic lock slider.
- b. Polypropylene Hardware:
 - 1) Clips:



- a) Provide clips fabricated from black ultraviolet-stabilized polypropylene.
- 2) Twist Locks:
 - a) Provide twist locks fabricated from black ultraviolet-stabilized polypropylene.
- 3) Net Ties:
 - a) Provide net ties fabricated from black ultraviolet-stabilized polypropylene.
- 4) Quick Tie Chains:
 - a) Provide 24-inch (610mm) long quick tie chains fabricated from black ultraviolet-stabilized polypropylene.
- 5) Cords:
 - a) Provide cords fabricated from black ultraviolet-stabilized polypropylene.

2.02 ACCESSORIES

A. Surface Disinfectants:

- 1. Bird Dropping Remover:
 - a. Provide a non-toxic, biodegradable bird dropping remover capable of instantly, safely, and effectively dissolving bird droppings, both wet and dry, in or out of a marine environment.
 - b. Manufacturers:
 - 1) ABC Advanced Bird Control, Division of Nixalite of America, Inc., Steri-Fab, <http://www.abcbirdcontrol.com>.
 - 2) Approved equal.
- 2. Surface Disinfectant and Bactericide:
 - a. Provide a surface disinfectant and bactericide capable of neutralizing bird waste germs.
 - b. Manufacturers:
 - 1) ABC Advanced Bird Control, Division of Nixalite of America, Inc., Steri-Fab, <http://www.abcbirdcontrol.com>.
 - 2) Approved equal.
- 3. Surface Cleaner and Deodorizer:
 - a. Provide a non-toxic, biodegradable surface cleaner and deodorizer that is safe and effective for both wet and dry environments, and capable of sanitizing the surface and removing residual odors and stains from bird inhabitation.
 - b. Manufacturers:
 - 1) ABC Advanced Bird Control, Division of Nixalite of America, Inc., Microcide-SQ, <http://www.abcbirdcontrol.com>.
 - 2) Approved equal.
- 4. Anti-bacterial soap and lotion
 - a. To compliment the use of personal protection equipment (PPE) by the installers, provide anti-bacterial soap and lotion capable of preventing



disease transmission in the installers after they have worked around surfaces contaminated with bird and animal wastes.

- b. Manufacturers:
 - 1) ABC Advanced Bird Control, Division of Nixalite of America, Inc., Microsan, <http://www.abcbirdcontrol.com>.
 - 2) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Make a thorough examination of the areas to receive the Work of this Section to verify there are ready for the installation of the pest controls.
 - a. Visually inspect the surfaces that will receive the bird netting hardware and the areas that will end up behind or inside the bird netting installation.
 - b. Note damaged surfaces or incomplete construction that could compromise the bird netting installation.
 - c. Note areas, surfaces, or objects that may require maintenance or periodic replacement after the bird netting is installed, such as lights, electrical equipment, and similar items.
 - d. Note objects or conditions that could damage the installed bird netting.
 - 2. Field Measurements:
 - a. Verify the dimensions of the areas to be enclosed.
- B. Evaluation and Assessment:
 - 1. Prior to installing the pest controls, notify the Program/Project Manager in writing of defects discovered which could affect the satisfactory completion and/or performance of the Work of this Section.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the pest controls.
- B. Surface Preparation:
 - 1. Prior to installing pest controls, ensure that all surfaces are clean, dry, and free of obstructions.
 - 2. Use surface cleaning products to neutralize bird droppings, nests, and related waste materials that may be present.
 - a. Allow all surfaces to air dry completely, and then reapply surface cleaning products to sanitize and deodorize the surface before proceeding.



- b. Strictly comply with the treatment instructions provided with the surface cleaning products.

C. Demolition/Removal:

1. Treat, neutralize, and safely remove all bird waste from the installation surfaces.

3.03 INSTALLATION

A. Install the bird netting hardware as recommended by the manufacturer.

1. Obtain the bird netting and bird netting hardware installation guidelines, and review and become completely familiar with the proper installation procedures for the bird netting.
2. Ensure that a sufficient quantity of bird netting, netting hardware, and surface cleaning products are available to properly install the bird netting system.
3. In all surface types where large screw eyes are to be installed, drill pilot holes.
4. In concrete where sidewinders are to be installed, drill pilot holes.
5. Secure clips to the perimeter using the hardware recommended by clip manufacturer.

B. Install bird netting as recommended by the bird netting manufacturer.

1. Install perimeter and support hardware first, then attach the bird netting to the installed hardware, and finally install access or additional support hardware as required.
2. Stretch open the bird netting, which comes in collapsed mesh form, to the specified size
 - a. If necessary, cut the bird netting to fit the area.
 - b. If multiple pieces are needed, join the pieces together with the recommended seam fastening hardware.
3. Fasten the bird netting to the types of surface shapes and materials occurring in the area where the bird netting is to be installed.
 - a. For fastening the netting fabric to all types of objects, provide multi-purpose fastener net ties.
 - 1) Provide net ties to prevent netting sag or loose fitting nets by securing the netting to objects above or behind netting installation.
 - b. For attaching the bird netting mesh to the cables, for closing seams, and for fastening the “net zippers” to the bird netting mesh, provide net rings.
 - 1) When attaching bird netting to the cable system, clips can be used in place of net rings.
4. Ensure that the installed bird netting is taught, and free of wrinkles, gaps and openings.
 - a. To prevent net sag, provide quick tie chains for fastening the bird net to objects above or behind netting installation.



5. Seam Fastening:
 - a. To join 2 overlapped pieces of netting together at a seam, provide twist locks.
 - b. To reinforce seams, patch tears, close circular openings, provide overhead support, and for similar applications, provide cords as multi-purpose fasteners.
6. Install the bird netting so objects or conditions that could damage the bird netting are avoided.
 - a. Install the bird netting so contact with machinery, vehicles, extreme heat, tree branches, and similar problematic items are avoided.
 - b. Make the adjustments necessary to keep the netting a sufficient distance from problematic objects or conditions.
7. To allow access to the areas behind the bird netting installation, provide net zippers.

3.04 SITE QUALITY CONTROL

- A. Inspections:
 1. Inspect the finished bird netting installation for compliance with the specified requirements.
- B. Non-Conforming Work
 1. Bird netting that is not taut, and free of wrinkles, gaps and openings is unacceptable; and must be corrected.

3.05 ADJUSTING

- A. Make the adjustments needed so the installed bird netting conforms to the manufacturer's installation guidelines.

3.06 CLEANING

- A. Waste Management:
 1. Remove debris and waste materials from the Site.
 2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Use anti-bacterial personal protection equipment (PPE) and products complying with the requirements specified in 29 CFR 1926 to help prevent disease transmittal when working around surfaces contaminated with bird droppings.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 10451

DETECTION AND COUNTING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for automatic passenger counters (APC). ← Scope Deletion of APC RFI
0302

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01732 - Cutting and Patching.
4. Section 01780 - Closeout Submittals.
5. Section 01810 – Commissioning.
6. Section 16061 - Electrical Grounding and Bonding.
7. Section 16120 - Conductors and Cables.
8. Section 16123 - Control-Voltage Power Cables.
9. Section 16130 - Raceway and Boxes.
10. Section 16134 - Cable Trays.
11. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. AC: Alternating electric current.
2. APC: Automatic passenger counter.
3. CAN: Controller area network.
4. DC: Direct electrical current.
5. EMC: Electromagnetic compatibility.
6. IDF: Intermediate Distribution Frame.
7. LAN: Local area network.
8. LED: Light emitting diode.
9. MTBF: Mean time between failures.
10. PC: Personal computer.
11. UIP: Universal IRIS Protocol.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Enclosure: Control panel, console, cabinet, or instrument housing.



3. Ethernet: A family of frame-based computer networking technologies for local area networks (LANs).
4. RS-232: A Telecommunications Industry Association (TIA) recommended standard for asynchronous serial data communications between terminal devices that complies with the requirements specified in ANSI/TIA 232-F.

C. Reference Standards:

1. British Standards Institute (BSI):
 - a. BS EN 50121-3-2: - Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus.
 - b. BS EN 50155: - Railway applications. Electronic equipment used on rolling stock.
 - c. BS EN 60721-1 - Classification of environmental conditions. Environmental parameters and their severities.
 - d. BS EN 60721-3-0 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Introduction.
 - e. BS EN 60721-3-1 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Storage.
 - f. BS EN 60721-3-2 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Transportation.
 - g. BS EN 60721-3-3 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Stationary use at weatherprotected locations.
 - h. BS EN 60721-3-4 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Stationary use at non-weatherprotected locations.
 - i. BS EN 60721-3-5 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Ground vehicle installations.
 - j. BS EN 60721-3-6 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Ship environment.
 - k. BS EN 60721-3-7 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Portable and non-stationary use.
 - l. BS EN 60721-3-9 - Classification of environmental conditions. Classification of groups of environmental parameters and their severities. Microclimates inside products.
 - m. BS EN 60825 - Safety of laser products. Laser guards.



- n. BS EN 61000-6-2 – Electromagnetic Compatibility (EMC). Generic Standards. Immunity for industrial environments.
- o. BS EN 61000-6-3 – Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments.
- p. BS EN 61373 - Railway applications. Rolling stock equipment. Shock and vibration tests.
- 2. Deutsches Institut für Normung E.V. (DIN):
 - a. DIN 41652-1 – Rack and Panel Connectors, Trapezoidal, Round Contacts 1 mm; Common Mounting Features and Dimensions; Survey of Types.
 - b. DIN 41652-2 - Rack and Panel Connectors, Trapezoidal, Round Contacts 1 mm; Ratings, Requirements, Tests.
 - c. DIN 41652-3 - Rack and Panel Connectors, Trapezoidal, Round Contacts 1 mm; Dimensions of Type A; Solder Termination for Free Wiring.
 - d. DIN 41652-5 - Rack and Panel Connectors, Trapezoidal, Round Contacts 1 mm; Dimensions of Type C; Crimp Termination for Free Wiring.
- 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 4. International Electrotechnical Commission (IEC):
 - a. IEC 60529 - Degrees of protection provided by enclosures (IP Code).
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
- 6. Telecommunications Industry Association (TIA):
 - a. ANSI/TIA 232-F – Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
- 7. Underwriters Laboratories, Inc. (UL):
 - a. UL 94 – Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - b. UL 1283 – Standard for Electromagnetic Filters.
 - c. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Hardware data.
 - 2) Software data.
 - 3) Sequence of Operation Narratives.
 - b. Shop Drawings:
 - 1) System documents.
 - 2) System schematics.
 - 3) Communication system architectures.
 - 4) Panel Installation and Block Diagram.
 - 5) System Drawing Index.
 - c. Delegated Design Submittals:
 - 1) Detection and Counting Equipment Functional Design Manual.
 - d. Special Procedure Submittals:
 - 1) Passenger Detection and Counting System Commissioning Report.
 - 2) System Performance Verification Test Procedures.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) System Performance Verification Test Report.
 - b. Manufacturer's Instructions:
 - 1) Passenger detection and counting system manufacturer's printed installation instructions.
- C. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Passenger Detection and Counting System Operation and Maintenance Manuals.
 - 2) Passenger Detection and Counting System Hardware Manual.
 - 3) Passenger Detection and Counting System Software Manual
 - b. Warranty Documentation:
 - 1) Detection and Counting Device Materials Warranty.
 - 2) Detection and Counting Device Installation Warranty:
 - c. Record Documentation:
 - 1) Passenger Detection and Counting System Record Drawings.
 - d. Software:
 - 1) Final detection and counting system software electronic files.



1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 - 1. Handle materials and equipment in accordance with the manufacturer's written instructions.
 - 2. Follow the manufacturer's written instructions for storing the items.
 - a. Maintain the temperature around sensors between minus 40 degrees Fahrenheit and 176 degrees Fahrenheit (minus 40 degrees Celsius and 80 degrees Celsius) during storage and transport.
 - b. Maintain the relative humidity around sensors at no more than 95 percent, non-condensing, during storage and transport.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.05 WARRANTY/BOND

- A. Manufacturer Warranty:
 - 1. Detection and Counting Device Materials Warranty:
 - a. Warrant the detection and counting device equipment against defects within the 1-year period after the Date of Substantial Completion:
 - 1) Submit a Detection and Counting Device Materials Warranty on the detection and counting device manufacturer's standard or customized form, without monetary limitation, in which the detection and counting device manufacturer agrees to replace detection and counting device equipment that fails under normal operating conditions within the specified warranty period to the Program/Project Manager for approval.
- B. Special Warranty:
 - 1. Detection and Counting Device Installation Warranty:
 - a. Warrant the detection and counting device equipments' installation workmanship against failures under normal operating conditions



beginning at the Date of Substantial Completion and extending until 1 year after the Date of Substantial Completion:

- 1) Include the removal and reinstallation, maintenance, and support of the detection and counting device equipment in the Warranty.
- 2) Submit a Detection and Counting Device Installation Warranty on the detection and counting device manufacturer's standard or customized form, without monetary limitation, in which installer agrees to repair detection and counting device equipment that fails within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 DETECTION AND COUNTING SYSTEMS EQUIPMENT

A. Manufacturers:

1. Manufacturer List:

- a. Iris-GmbH Infrared and Intelligent Sensors, IRMA InfraRed Motion Analyzer Automatic Passenger Counter (APC) System, https://www.irisgmbh.de/wp-content/uploads/DB_dist4_08-rev2_3-e.pdf.
- b. Manufacturer providing an equivalent product approved by the Program/Project Manager.

2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

3. Product Options:

a. Product Data:

- 1) Obtain Product Data for the products proposed for the detection and counting device equipment provided under this Section as follows:

a) Hardware Data:

- (1) Obtain hardware Product Data consisting of, but not limited to, data sheets and catalog cuts which document compliance of the devices and components with the requirements specified in this Section.
 - (a) Any exceptions taken to the specified requirements must be noted and addressed.
- (2) Prepare a Bill of Materials for the detection and counting system, which will then function as the Table of Contents for the detection and counting system hardware Product Data submittal.



- (a) Include each device's unique identifier, the device function, its manufacturer, and its model/part/catalog number used for ordering.
 - b) Software Data:
 - (1) Obtain software Product Data consisting of descriptions of the operation and capability of the proposed software, which document compliance with all aspects of the operation and capabilities specified.
 - (a) Any exceptions taken to the specified requirements must be noted and addressed.
 - (2) Furnish a description of any modification or custom design required to meet the Contract requirements that are not covered by the standard software.
 - c) Sequence of Operation Narratives:
 - (1) Furnish a sequence of operation that reflects the language and format of this Section, and that refers to the devices by their unique identifiers as shown on the Contract Drawings.
 - (a) Furnish a sequence of operation for each sub-system.
 - 2) Submit the detection and counting device equipment Product Data for the products proposed for the Work of this Section to the Program/Project Manager for approval.
- B. Description:
- 1. Provide a complete turnkey automatic passenger counting system capable of counting and analyzing the movement of passengers at 3 PHX Sky Train stations.
 - a. The Work at each station consists of providing counters at 8 berths, each berth having 2 doors; and each door requiring 3 sensors.
 - b. The Work includes providing the door contacts, analyzers, conduit, cable trays, wiring, panels, software, and other equipment required to produce a complete operational and functional automatic passenger counting and analysis system.
 - 2. Regulatory Requirements:
 - a. Phoenix Building Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with requirements specified in NFPA 70.



C. Performance:

1. Mean Time Between Failures (MTBF):
 - a. Provide an automatic passenger counting system capable of 300,000 hours of continuous operation at 77 degrees Fahrenheit (25 degrees Celsius) on average between failures.
2. Sensors:
 - a. Temperature Range:
 - 1) Provide infrared distance sensors capable of operating in the temperature range from minus 13 degrees Fahrenheit (minus 25 degrees Celsius) to 158 degrees Fahrenheit (70 degrees Celsius).
 - b. Relative Humidity:
 - 1) Provide infrared distance sensors capable of operating in relative humidity up to 95 percent, non-condensing.
3. Analyzer:
 - a. Accuracy:
 - 1) Provide an analyzer capable of reliably distinguishing people from other objects using the raw data generated by the system with an accuracy of at least 96 percent.

D. Design Criteria:

1. Electromagnetic Compatibility (EMC):
 - a. Design the passenger detection and counting system to comply with the electromagnetic compatibility (EMC) requirements specified in BS EN 61000-6-2 and BS EN 61000-6-3.
2. Sensors:
 - a. Provide infrared distance sensors designed to measure laser impulse runtime to measure the distance between the sensor and the object whose distance is being measured.
 - 1) Provide sensors designed to emit high frequency modulated light, and sense the light reflected from the object whose distance is being measured.
 - 2) Provide sensors designed to emit class 1 laser light complying with the requirements in the range safe for the eye.
 - 3) Provide sensors designed to evaluate the three-dimensional direction of the reflected light received, by evaluating distance signals received from a 2 by 2 matrix of receptors via 4 channels.
 - 4) Provide sensors designed to be configured for a sensor specific baud rate up to 1000 kilobits per second, sensor address, and sensor priority as master or slave.
 - b. Laser Beam:



- 1) Provide sensors having a laser diode that emits a laser beam through a transmitter lens which is capable of splitting the laser beam into 4 “spots”.
 - 2) Offset the source point of the transmitter and the optical axis of the receiver optics laterally so superimposition of the transmitter and receiver fields exists only from a certain minimum distance from the sensor.
 - c. Measurement Distances and Digital Image Resolution:
 - 1) Provide sensors designed to measure distance in 2 height ranges, A and B:
 - a) Height Range A:
 - (1) For Height Range A, provide sensors designed to measure distances 0 cm to 250 cm from the housing cover surface.
 - (2) For Height Range A, provide sensors designed to measure distance from the housing cover surface in digits from 0 to 250.
 - (3) To determine the proper digital image exposure for Height Range A, provide sensors designed to have a resolution of 136 digits when measured according to the KODAK Gray Card / R-27 system.
 - b) Height Range B:
 - (1) For Height Range B, provide sensors designed to measure distances 50 cm to 350 cm from the housing cover surface.
 - (2) For Height Range B, provide sensors designed to measure distance from the housing cover surface in digits from 0 to 250.
 - (3) To determine the proper digital image exposure for Height Range B, provide sensors designed to have a resolution of 176 digits when measured according to the KODAK Gray Card / R-27 system.
 - d. Duration of Measurements:
 - 1) Provide sensors designed to take 4 serial measurements in 4 milliseconds, taking 1 millisecond for each measurement.
 - e. Provide infrared distance sensors designed to operate on a 12-Volt DC power supply.
 3. Door Contacts:
 - a. Provide potential-free door contacts designed to detect the open/closed status of the doors, and of interfacing with switching inputs on the analyzer.
 4. Analyzer:



- a. Provide infrared motion analyzers designed to record and process the raw sensor signal data generated when the sensors detect passengers exiting and entering doors, and calculate the number of passengers exiting and entering.
 - b. Provide infrared motion analyzers designed to be connected by a common shielded cable to the infrared distance sensors across the integrated controller area network (CAN) interface.
 - 1) Storage Protocol:
 - a) Provide an analyzer designed to reduce and store raw data received from the sensors until the analyzer is queried by an application residing on a remote server to furnish the data.
 - 2) Communications Protocol:
 - a) Provide an analyzer designed to send and receive serial data to and from a server in RS232 data format as defined in ANSI/TIA 232-F.
 - c. Analyzer Interface:
 - 1) Between the analyzer and storage and communications systems, provide a Wireless Modem or an Ethernet interface connection designed to transmit system prompts to store data, or extract and send the stored data.
 - d. Provide an analyzer designed to operate on a 12-Volt or 24-Volt power supply.
5. Controller Area Network (CAN):
- a. Provide a linear wiring scheme wherein the sensors are connected via distributors or wiring boxes, and short or extended branch lines.
 - b. Transceiver:
 - 1) As the interface between the Controller Area Network (CAN) and the physical bus, provide a high speed transceiver.
 - c. Data Bus:
 - 1) Provide a modular and flexible data bus system designed to send data in RS232 serial format from the analyzer to the computer (PC) when a door in the system closes.
 - 2) Provide an electric bus that is at least 30 meters long, depending on the type of cable used, the number of sensors, and the bit rate.
 - a) The physically allowable bus length is shorter than the electrical bus length because the electrical bus length must take into account branch lines, which count as double.
6. Noise Filter:
- a. Provide a noise filter capable of designed to reduce normal mode transients to plus or minus 2 Volts, and to have a surge current capacity up to 45,000 Amperes.
7. Software:



- a. Provide a software application capable of capturing the data from multiple berths simultaneously, time stamping the data, storing it to a database, and having a user interface allowing controllers to access the data.
 - b. Provide a software application having the capability to generate built-in reports and extensive query and selection criteria, including at a minimum the following:
 - 1) Passenger traffic counts.
 - 2) Boardings by station.
 - c. Provide software tools that facilitate configuration and visualization.
 - d. 30 days before the date scheduled for the training course, submit 2 sets of the final passenger detection and counting system software electronic files on compact discs having read only memory (CD-ROM) to the Program/Project Manager.
8. Shop Drawings:
- a. Prepare Shop Drawings of the passenger detection and counting device equipment, including system documents illustrating the proposed system design, and data related to the products proposed for the Work of this Section.
 - 1) System Documents:
 - a) Use the same abbreviations, symbols, nomenclature and identifiers used in the Contract Documents.
 - b) Furnish each system element shown on a system drawing with a unique identifier as shown on Contract Drawings.
 - c) Submit system documents that include all or part the following as applicable:
 - (1) Analysis of system requirements:
 - (a) Include system descriptions, analyses, and calculations that were used to size the equipment specified.
 - (b) Furnish descriptions and calculations that show how the equipment will operate as a system to furnish the specified performance.
 - (c) Include an analysis of start-up operations.
 - (d) Include expansion capability and a method of implementation.
 - (e) Include a sample copy of each report specified.
 - (f) Include a color print representative of typical graphics.
 - 2) System Schematics:
 - a) Furnish system schematics that shows the control and mechanical devices associated with the system.
 - b) Include a system schematic drawing for each sub-system.



- 3) Communication System Architectures:
 - a) Furnish complete communication-system architectures.
- 4) Panel Installation and Block Diagram:
 - a) Furnish a panel installation and block diagram.
- 5) System Drawing Index:
 - a) Furnish a system drawing index that shows the name and number of the building or other similar designation; and that lists the system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.
 - b) Furnish a system legend on the system drawings that shows generic symbols and the name of the devices shown.
- b. Within the 2 months after the official Notice to Proceed (NTP), submit the passenger detection and counting device equipment Shop Drawings to the Program/Project Manager for approval.
 - 1) Submit the system drawings together as a complete submittal.
9. Passenger Detection and Counting Equipment Functional Design Manual:
 - a. Prepare a Passenger Detection and Counting Equipment Functional Design Manual for the entire passenger detection and counting system that identifies the operational requirements for the system, and explains the theory of operation, design philosophy, and specific functions.
 - 1) Include a description of the hardware and software functions, interfaces, and requirements for all system operating modes.
 - b. 30 days before the training course, submit the Functional Design Manual to the Program/Project Manager for approval.

E. Components:

1. Sensors:
 - a. Provide three-dimensional, 4-channel, high frequency infrared laser distance sensors.
 - b. Housing:
 - 1) Provide a die cast zinc sensor housing having a removable polycarbonate cover, which serves as an infrared daylight elimination filter, fastened to the housing with screws.
 - 2) Provide a rated enclosure complying with the requirements for protection class IP64 specified in IEC 60529.
 - c. Interface with Controller Area Network (CAN):
 - 1) Provide each sensor with a shielded cable and connector interface across which the sensor communicates with the rest of the detection and counting system, and over which direct current electrical power is supplied to the sensor through the analyzer.



- 2) Cables:
 - a) Provide flexible 2 X 2 X 0.14mm² (26AWG) twisted pair shielded data cables having stranded copper conductors, an overall tinned copper screen, and halogen-free insulation with improved fire retarding performance.
- 3) Cable Connectors:
 - a) Provide D-subminiature (D-Sub) plug connectors having 9-pin layouts complying with the requirements specified in the DIN 41652 series of standards.
2. Door Contacts:
 - a. Provide potential-free door contacts capable of detecting the open/closed status of a door, and of interfacing with 3 galvanically separated switching inputs on the analyzer.
3. Analyzer:
 - a. Provide a modular analyzer having its components mounted in a stainless steel housing.
 - 1) Include a central power supply, a processing kernel consisting of a microcontroller and memory, the Controller Area Network (CAN) line driver, an RS232 service interface containing the operating data interface to the computer and signal inputs, and a data logger memory with a real time clock.
 - 2) Include a custom-designed firmware device that controls the interaction between the components by accounting for aspects such as communications protocols, data shaping, and routine adjustment.
 - b. Switching Inputs:
 - 1) Provide an analyzer having switching inputs capable of receiving sensor input which starts and stops the system to count
 - a) For use as door signal inputs, provide 3 galvanically separated switching inputs that are potential-free, opto-coupled, digital control units.
 - b) Furnish a short-circuit-proof and galvanically separated auxiliary voltage to control the switching inputs.
 - c. Data Lines:
 - 1) Provide an analyzer having a 2-wire data port interface for serial communication with the computer.
 - 2) Provide data lines designed to separate potentials, and to be short-circuit-proof and protected from inadvertent connection to other voltages.
 - d. Service Interface:



- 1) Provide an analyzer having a RS232 serial communication service interface to the computer via shielded lines for starting up, configuring, and maintaining the analyzer.
 - a) Provide a serial communication interface capable of handling a baud rate in the range between 300 Baud and 115,200 Baud.
 - b) To supply current to interface converter devices, furnish an auxiliary 12-Volt voltage output protected against over-current in accordance with the requirements specified in ANSI/TIA 232-F.
- 2) Provide a service interface having data lines, handshake lines to signal to request or send data, control lines for signaling and switching between counter and boot modes, and an auxiliary voltage output.
- 3) Provide a service interface capable of configuring the system and downloading software as required, but not used during normal operations.
- e. Sensor Interface:
 - 1) Provide an analyzer having a four-wire shielded Controller Area Network (CAN) bus system, using 2 wires for power and 2 wires for signals for connecting sensors to the analyzer.
- f. Operating Interface:
 - 1) Provide an analyzer having switching inputs connected to the auxiliary "door" voltage of the analyzer for registering door status signals.
 - 2) Provide an analyzer having a galvanically separated data interface for transmitting counter data to the computer via shielded or unshielded wires stranded in pairs.
- g. DC-DC Transformer:
 - 1) Provide an analyzer having a DC-DC transformer that furnishes the electric power required by the complete system, including internal logic voltage and sensor supply voltage.
 - a) Provide a DC-DC transformer capable of supplying the required voltage levels under galvanic separation.
 - b) Equip the DC-DC transformer with an input power limiter and thermal overload protection.
 - c) Equip the DC-DC transformer with a time-lag fuse to safeguard the input in the event the transformer is defective.
 - 2) Provide polarity protection for the inputs.
- h. Indicator Lights:
 - 1) Provide a red LED indicator light to indicate reset mode during voltage connection and initialization.



- 2) Provide a yellow LED indicator light to indicate configuration mode, the initial boot mode..
 - 3) Provide a green LED indicator light to indicate operational readiness mode and counting method.
 - i. Provide an analyzer capable of either processing the data acquired immediately by use of a computer, or of logging the data for processing by use of a computer at a later stage.
4. Wireless Modem/Ethernet Switch/Computer (PC):
 - a. Provide a wireless modem or Ethernet switch, and a computer capable of summing the numbers of passengers entering and exiting each door at each station.
5. Controller Area Network (CAN):
 - a. Transceiver:
 - 1) Between the Controller Area Network (CAN) controller and the physical bus, provide a pin compatible, high speed transceiver having 2 modes of operation; a normal mode in which the differential capability to transmit and receive data via the bus at rates up to 1 Megabaud is present, and a passive standby mode in which the transmitter and receiver are switched off.
 - a) Provide a transceiver having excellent electromagnetic compatibility (EMC) performance, capable of passive behavior when the supply voltage is off, using low current when in standby mode, and having remote wake-up capability via the bus.
6. Noise Filter:
 - a. Provide a connected high-frequency noise filter complying with the requirements specified in UL 1283.
 - b. Manufacturers:
 - 1) Emerson Network Power, Islatrol®+102,
<http://emersonnetworkpower.com/en-US/Products/SurgeProtection/Plug-in/Pages/IslatrolICSeries.aspx>.
 - 2) Manufacturer providing an equivalent product approved by the Program/Project Manager.
7. AC/DC Converter:
 - a. Provide an AC/DC converter capable of converting alternating current supply line voltage to the direct current voltage required by the system for operation.
8. Antenna:
 - a. Provide a communications antenna.
 - b. Manufacturers:
 - 1) CalAmp, RM1353-TB-04.



- 2) Manufacturer providing an equivalent product approved by the Program/Project Manager.
9. Enclosures:
 - a. If required, provide enclosures for the system components.

2.02 ACCESSORIES

- A. Electrical Conduit:
 1. Provide electrical conduit complying with the requirements specified in Section 16130, Raceway and Boxes.
- B. Cable Trays:
 1. Provide electrical conduit complying with the requirements specified in Section 16134, Cable Trays.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
 2. Verify that the installed conduit and wire quantities, sizes, and types are suitable for the detection and counting system equipment being provided under this Contract.
 - a. Verify that conduit stub-ups to be mated with the detection and counting system equipment are the correct type and size, and are at the proper location.
 - b. Inspect the condition of the existing conduit that is required for the Work of this Section.
- B. Evaluation and Assessment:
 1. Proceed to install the detection and counting system devices only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the passenger detection and counting system devices.
- B. Demolition / Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.



3.03 DETECTION AND COUNTING DEVICE INSTALLATION

- A. Sensors:
 - 1. In accordance with the passenger detection and counting system manufacturer's printed installation instructions, flush mount the sensors in the header beam above the doors where indicated on the Contract Drawings.
- B. Analyzer;
 - 1. In accordance with the passenger detection and counting system manufacturer's printed installation instructions, do not mount the device in areas where dust or abrasive particles may accumulate, where humid air streams may produce condensation, or on vibrating components or on components subject to shock.
- C. Antenna:
 - 1. Locate the antenna at least 20 cm away from passengers, bystanders, and other personnel in order to comply with FCC regulations.
- D. Electrical Wiring:
 - 1. Connect the passenger detection and counting system power wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.
 - 2. Connect the passenger detection and counting system control wiring in accordance with the requirements specified in Section 16123, Control-Voltage Power Cables.
 - 3. Electrical Grounding:
 - a. Ground the passenger detection and counting system in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 - 4. Controller Area Network (CAN):
 - a. Provide a linear wiring scheme wherein the sensors are connected via distributors and short branch lines.
 - b. Connect sensors to the analyzer via a common shielded cable.
- E. Submit the passenger detection and counting system manufacturer's printed installation instructions to the Program/Project Manager for information.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:
 - a. The passenger detection and counting system must be tested by the manufacturer of the system equipment.



- 1) Upon completion of each portal, conduct a Functional Acceptance Test of the portal system for the Program/Project Manager.
2. Site Inspections:
 - a. Passenger Detection and Counting System Panels:
 - 1) Have the passenger detection and counting system manufacturer inspect the following control panel components to verify their proper installation:
 - a) Wire labeling.
 - b) Panel schedule accuracy.
- B. Non-Conforming Work
 1. Correct the discrepancies or problems identified during each test at no increase in Contract Price.
- C. Manufacturer Services:
 1. Employ a manufacturer's representatives to provide installation certificates and to assist with the system startup.

3.05 SYSTEM STARTUP

- A. Commissioning:
 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 16995, Commissioning of Electrical Systems, for the pertinent passenger detection and counting systems Work of this Section.
 2. Conclude the commissioning period by conducting the Performance Verification and Acceptance Tests.
 3. System Commissioning Report:
 - a. Prepare a Passenger Detection and Counting System Commissioning Report that includes the data collected during the system commissioning procedures, and that follows the format of the commissioning procedures.
 - 1) Include all configuration check sheets with the final values listed for all parameters, set points, time delays, constants, calibration data for all devices, results of adjustments, and results of testing.
 - b. Submit the System Commissioning Report to the Program/Project Manager within the 30 days after completion of system commissioning.
- B. After the passenger detection and counting system manufacturers' installation certificates for active devices have been received by the Program/Project manager, provide the initial power to the system.
 1. Perform the initial operational testing during this period.



2. Correct defects as they are detected to put the system into operation.
- C. System Performance Verification and Acceptance Tests:
 1. 30 days before the scheduled System Performance Verification Test date, submit the System Performance Verification Test Procedures to the Program/Project Manager and the City of Phoenix Aviation Department for approval.
 - a. In the performance verification test procedures, refer to the devices by their unique identifiers; and explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the specified sequences of operation, and other Contract requirements.
 - b. Submit a system performance verification test equipment list that lists the test equipment to be used during the performance verification testing to the Program/Project Manager for approval.
 - 1) Include the test equipment manufacturer's name, the test equipment's model number, the test equipment's function, the date of the test equipment's latest calibration, and the results of the test equipment's latest calibration.
 - c. Within the 30 days after completion of the System Performance Verification Test, submit the System Performance Verification Test Report to the Program/Project Manager and the City of Phoenix Aviation Department for approval.
 - 1) Include the data collected during the system performance verification test in System Performance Verification Test Report.
- D. If the system does not pass the Performance Verification and Acceptance Tests due to deficiencies, continue the commissioning period until the Performance Verification and Acceptance Tests are completed and the system is accepted.

3.06 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

- A. Training:
 1. In accordance with the requirements specified in Section 01770, Closeout Procedures, employ a representative from the detection and counting device equipment manufacturer who is fully qualified, trained, and



thoroughly knowledgeable regarding the specific equipment installed under this Contract to train the Owner's personnel responsible for operating the system and representatives of Operations to adjust, operate, and maintain the system.

- a. The Phoenix Sky Harbor International Airport will provide adequate training facilities for each training session.
- b. Furnish training consisting of not less than four 8-hour sessions.

B. Record Documentation:

1. The Phoenix Sky Harbor International Airport will provide electronic background drawings to be used to prepare Record Drawing submittals.
2. Legibly mark the electronic background drawings to create Record Drawings that record the final and actual "As-Built" passenger detection and counting system installation.
 - a. Mark each edited electronic as-built drawing with the words "Record Document".
 - b. Include all noted and design changes pertaining to the passenger detection and counting system "as built" conditions on a set of permitted construction documents for the City of Phoenix Aviation Department's records.
 - c. Include field changes of dimensions and details, changes in details from those indicated on the Contract Drawings, details not on the original Contract Drawings, the make and model of the actual products installed, and the following additional information:
 - 1) Drawing Index and a System Legend.
 - 2) A system schematic and equipment schedule.
 - 3) The Sequence of Operation.
 - 4) Complete communication-system architectures, including information on applicable network addressing, DIP switches, and jumpers.
 - 5) Floor plans showing the location of key system components, and the routing of the communications lines.
 - 6) Enclosure drawings, segregated by enclosure, and having the following details:
 - a) Bill of material, including required spares.
 - b) Component layout plans.
 - c) Complete wiring schematics.
 - d) Port/connector layout plans for cross-patch termination assemblies.
 - 7) An input and output (I/O) point listing, including all software and hardware points, and complete with configuration details for each point, segregated by enclosures.



- d. Include schedules and related drawings documenting the usage/assignments of each assembly.
 - e. Include cable lists specifying the cable, wire pair, and connector and pin assignments for all signal, power, and ground leads.
 - f. Include the operating parameters of individual devices.
 - g. Include a tabulation of node addresses for the local area network (LAN), and for other network addressing where applicable; and for locations where fixed communication is configured among system nodes in pairs/groups include the tabulation of node addresses of all members of each pair/group.
3. 30 days before the date scheduled for the training course, submit the Passenger Detection and Counting System Record Drawings to the Program/Project Manager for review.
 - a. Should additional information or revisions be required, the reviewed documents will be returned to the Contractor for correction and re-submittal to the Program/Project Manager.

3.08 PROTECTION

- A. Take steps to insure that installed detection and counting system devices are protected during subsequent construction activities.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 1. Operation and Maintenance (O&M) Manuals:
 - a. Prepare Operation and Maintenance (O&M) Manuals for the passenger detection and counting system provided under this Section.
 - b. In the maintenance portion of the manual, include descriptions of maintenance for the passenger detection and counting system equipment, including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
 - c. In the operation portion of the manual, fully explain the procedures and instructions for the operation of the passenger detection and counting system, including the following items:
 - 1) Computers and peripherals.
 - 2) System start-up and shutdown procedures.
 - 3) Use of the system and applications software.
 - 4) Recovery and restart procedures.
 - 5) Use of the report generator, and the generation of reports.
 - 6) Data entry.
 - 7) Operator commands.
 - 8) System entry requirements.



- 9) Color prints of the software screens on 8-1/2-inch by 11-inch paper.
 - 10) Scripts developed for the screen displays.
 - 11) Diagram showing how the screens are linked together.
 - d. 30 days before the date scheduled for the training course, submit 3 copies of the printed Passenger Detection and Counting System Operation and Maintenance Manuals to the Program/Project Manager for approval.
2. Passenger Detection and Counting System Hardware Manual:
 - a. Prepare hardware manuals for the passenger detection and counting system provided under this Section.
 - b. In the hardware manuals, describe all equipment furnished for the passenger detection and counting system, and include the following items:
 - 1) A general description and specifications of the hardware.
 - 2) Installation and checkout procedures.
 - 3) Equipment electrical schematics and layout drawings.
 - 4) System schematics and layout drawings.
 - 5) Alignment and calibration procedures.
 - 6) The equipment manufacturer's repair parts list indicating sources of supply.
 - 7) Interface definition.
 - c. Submit the Passenger Detection and Counting System Hardware Manuals to the Program/Project Manager for approval.
3. Passenger Detection and Counting System Software Manual:
 - a. Prepare software manuals for the passenger detection and counting system provided under this Section.
 - b. In the software manuals, describe the functions of all software furnished for the passenger detection and counting system, and furnish all other information necessary to enable proper loading, testing, and operation of the software including the following items:
 - 1) Definition of terms and functions.
 - 2) Use of system and applications software.
 - 3) Procedures for system initialization, start-up, and shutdown.
 - 4) Alarm reports.
 - 5) Reports generation.
 - 6) Directory of the disk files.
 - 7) Description of the communication protocols, including data formats, command characters, and a sample of each type of data transfer.
 - c. Submit the Passenger Detection and Counting System Software Manuals to the Program/Project Manager for approval.



END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 10520

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for fire extinguishers and fire extinguisher cabinets.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 2. City of Phoenix (COP):
 - a. International Building Code – 2012 with City of Phoenix amendments (IBC)
 - b. International Fire Code – 2012 with City of Phoenix amendments (IFC)
 - 3. FM Approvals LLC (FM):
 - a. FM Class Number 5420 – Carbon Dioxide Extinguishing Systems.
 - 4. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
 - 5. National Fire Protection Association (NFPA):
 - a. NFPA 10 - 2010 Standard for Portable Fire Extinguishers.
 - 6. Underwriter's Laboratories, Inc. (UL):
 - a. UL Guide No. 100 X0 - Extinguishers and Extinguishing System Units.

1.03 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Product Data:
 - 1) Portable fire extinguishers.
 - 2) Fire-protection cabinets.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Manufacturer's Instructions:
 - 1) Portable fire extinguisher manufacturer's written instructions.
 - 2) Fire-protection cabinet manufacturer's written instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

- a. Warranty Documentation:
 - 1) Portable fire extinguisher manufacturers' standard warranty.
 - 2) Fire-protection cabinet manufacturer's standard warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. NFPA Compliance:
 - a. Provide fire extinguishers fabricated and labeled in accordance with the requirements specified in NFPA 10.
2. Fire Extinguishers:
 - a. Provide fire extinguishers listed and labeled for type, rating, and classification by an independent testing agency acceptable to the Authorities Having Jurisdiction.
 - b. Provide extinguishers Underwriter's Laboratory Listed and FM Approved.
3. International Building Code – 2012 with City of Phoenix amendments
 - a. Perform the Work of this Section in accordance with requirements of the IBC.



1.06 WARRANTY

- A. Provide the fire protection specialty manufacturers' standard warranties, and submit them to the Program/Project Manager.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. J.L. Industries, Inc., www.buyjlinindustriesonline.com.
 - b. Larsen's Manufacturing Company, www.larsensmfg.com.
 - c. Potter-Roemer; Div. of Smith Industries, Inc., www.potterroemer.com.
 - d. Pre-approved equal.
 - 2. Product Options:
 - a. Submit the manufacturers' Product Data for each type of product specified and provided under this Section to the Program/Project Manager for approval.
 - 1) Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection specialties.
 - 2) For fire extinguishers, include the rating and classification of each.
 - 3) For cabinets, include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style
- B. Materials:
 - 1. Portable Fire Extinguishers:
 - a. Provide fire extinguishers of the type, size, and capacity as indicated in the Contract Documents for each cabinet and other locations.
 - b. Multipurpose Dry-Chemical Types:
 - 1) Provide UL-Listed 2-A:10:B:C, 5-pound nominal capacity portable dry-chemical fire extinguishers in an enameled-steel container.
 - 2) Provide UL-Listed 20-A:120:B:C, 20-pound nominal capacity portable dry-chemical fire extinguishers in an enameled-steel container.
 - 2. Fire-Protection Cabinets:
 - a. Cabinet Boxes:
 - 1) Provide semi-recessed cabinet boxes designed to be partially recessed in shallow depth walls, and suitable for encasing fire extinguishers of the size(s) provided.



- 2) Provide the manufacturer's standard enameled steel sheet box (tub) cabinet suiting the trim style, and having enameled steel sheet trim, frames, doors, and hardware.
 - a) Weld the cabinet's joints, and grind the welds smooth.
 - b) Miter and weld the cabinet perimeter at the door frame.
 - b. Cabinet Doors and Frames:
 - 1) Provide a combination door frame and perimeter trim piece having an exposed trim face that overlaps the surrounding wall surface and a 2-1/2-inch (64mm) deep wall return at the outer edge (backbend) with a rolled edge.
 - a) Fabricate hollow-metal door frames from a minimum of 1/2 inch (13mm) thick tubular stiles and rails.
 - 2) Fabricate solid cabinet doors according to manufacturer's standard design without glazing, and coordinate the door design with the cabinet type and trim style selected.
 - a) Provide a solid fire-protection cabinet door style having a lock similar to J.L. Industries, Inc. Ambassador Series Model 1017L22, or Model 1017L22FX for rated walls.
 - b) Pre-approved equal.
 - 3) Apply the words "FIRE EXTINGUISHER" to the door to indicate that there is a fire extinguisher in the cabinet.
 - c. Door Hardware:
 - 1) Provide the manufacturer's standard door-operating hardware, proper for the type of cabinet, trim style, door material, and style.
 - 2) Provide a cylinder lock for each cabinet.
 - 3) Provide a concealed or continuous-type hinge that permits the door to open 180 degrees.
 - d. Fire-Rated Cabinets:
 - 1) Provide cabinets listed and labeled to meet requirements of ASTM E 814 for the fire-resistance rating of wall where it will be installed.
 - 2) Fabricate fire-rated cabinets to have double 0.0478 inch (1.2mm) thick, cold-rolled steel sheet walls lined with 5/8 inch (16mm) thick, minimum, fire-barrier material.
 - e. Cabinet Mounting:
 - 1) Provide factory-drilled mounting holes for wall mounting hardware.
- C. Shop Finishing Methods:
 1. For recommendations for applying and designating finishes, comply with the requirements specified in NAAMM AMP 500.
 2. Colors and Textures:



- a. Provide the colors and textures selected by the Program/Project Manager from the manufacturer's full range for these characteristics.

2.02 ACCESSORIES

- A. Door Locks:
 1. Provide cylinder locks, with all cabinets keyed alike.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine walls and partitions to verify that suitable framing depths and blocking have been provided where recessed and semi-recessed cabinets are to be installed.
 2. Examine fire extinguishers to verify that they have been properly charged and tagged.

3.02 INSTALLATION

- A. Comply with the manufacturer's written instructions for installing fire-protection specialties.
 1. Submit the fire-protection specialty manufacturer's written instructions to the Program/Project Manager for information.
- B. Install fire-protection specialties in the locations and at the mounting heights indicated on the Contract Drawings, or if not indicated, at the heights acceptable to the Authority Having Jurisdiction (AHJ).
 1. Prepare recesses for the cabinets as required by the type and size of the cabinet and trim style.
 2. Fasten mounting brackets to the structure and cabinets, square and plumb.
 3. Fasten cabinets to the structure, square and plumb.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 10801

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for toilet and bath accessories.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01732 - Cutting and Patching.
4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

A. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - d. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Allow, High-Strength Low-Allow with Improved Formability, Solution Hardened, and Bake Hardenable.
 - e. ASTM B 16/B 16M - Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - f. ASTM B 19 - Standard Specification for Cartridge Brass Sheet, Strip, Plate, Bar, and Disks.
 - g. ASTM B 30 - Standard Specification for Copper Alloys in Ingot Form.
 - h. ASTM B 456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - i. ASTM C 1036 - Standard Specification for Flat Glass.
 - j. ASTM F 446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.
2. City of Phoenix (COP):



- a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
5. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. United States General Services Administration (GSA):
 - 1) Commercial Item Descriptions:
 - a) Commercial Item Description A-A-3002 – Mirrors, Glass.

1.03 INSTITUTE FOR SUSTAINABILITY INFRASTRUCTURE (ISI)

A. ENVISION RATING SYSTEM FOR SUSTAINABLE INFRASTRUCTURE - 2015 ISI, INC. ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the accessory locations with other Work to prevent interference with the clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of the accessories.
2. Deliver inserts and anchoring devices set into concrete or masonry as required so delays to the Work are prevented.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Paper towel dispensers.
 - 2) Jumbo roll toilet tissue dispensers.
 - 3) Grab bars.
 - 4) Sanitary napkin disposal units.
 - 5) Wall-mounted soap dispensers.
 - 6) Counter-mounted soap dispensers.
 - 7) Seat-cover dispensers.
 - 8) Mirrors.
 - 9) Folding utility shelves.



- 10) Waste receptacles.
- 11) Seat-cover and toilet tissue dispensers.
- 12) Combination seat-cover dispenser, sanitary napkin disposal, and toilet tissue dispenser units.
- 13) Napkin/tampon vendors.
- 14) Hand dryers.
- 15) Keys.
- b. Shop Drawings:
 - 1) Toilet and bath accessories.

B. Closeout Submittals:

- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance data for the toilet and bath accessories.
 - b. Warranty Documentation:
 - 1) Mirror Warranty.
 - c. Sustainable Design Closeout Documentation:
 - 1) Low-Emitting Materials: Adhesives & Sealants, Submittal for toilet and bath accessories.

1.05 QUALITY ASSURANCE

A. Sustainability Standards Certifications:

- 1. Adhesives and Sealants Submittal:
 - a. For the sealants and sealant primers used within the mirrors, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, signed by the product manufacturer certifying that these products comply with SCAQMD Rule 1168.

1.06 WARRANTY

A. Manufacturer Warranty:

- 1. Mirror Warranty:
 - a. Warrant the mirrors against failures within the 15-year period after the Date of Substantial Completion:
 - 1) Submit a Mirror Warranty on the mirror manufacturer's standard or customized form, without monetary limitation, in which the mirror manufacturer agrees to replace mirrors that fail or deteriorate in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.



- 2) Failures include, but are not limited to, the following:
 - a) Visible silver spoilage defects, including discoloration, black spots, and clouding of the silver film.

PART 2 PRODUCTS

2.01 TOILET AND BATH ACCESSORIES

A. Manufacturers:

1. Manufacturer List:
 - a. The basis of design products is listed in Schedule 10801-1 Basis of Design Toilet and Bath Accessories appearing at the end of this Section.
 - b. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed:
 - 1) American Specialties, Inc., www.americanspecialties.com.
 - 2) Bobrick Washroom Equipment, Inc., www.bobrick.com.
 - 3) Bradley Corporation, www.bradleycorp.com.
 - 4) Dyson Airblade, www.dysonairblade.com.
 - 5) General Accessory Manufacturing Co. (GAMCO), www.gamcousa.com.
 - 6) Georgia-Pacific Professional, www.gppro.com.
 - 7) McKinney/Parker Washroom Accessories Corp., www.americanspecialties.com.
 - 8) Waxie Sanitary Supply, www.waxie.com.
 - 9) Approved equal.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) For each type of accessory unit and for units exposed to view in the same areas, provide products of the same manufacturer unless otherwise approved by Program/Project Manager.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].



C. Sustainability Standards Certifications:

- a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior adhesives for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Multipurpose Construction Adhesives: Not more than 70 grams per Liter less water.
 - b) Structural Glazing Adhesives: Not more than 100 grams per Liter less water.
 - c) Contact Adhesives: Not more than 80 grams per Liter less water.
 - d) Special Purpose Contact Adhesives: Not more than 250 grams per Liter less water.

D. Performance:

- 1. Grab Bars:
 - a. Provide grab bars capable of withstand a downward load of at least 250 pounds-force (1112N) after installation when tested in accordance with the method specified in ASTM F 446.
- 2. Mirrors:
 - a. Provide mirrors that will not fail under normal usage from glass breakage and deterioration attributable to defective manufacture, fabrication, or installation.
 - 1) Deterioration of mirrors includes discoloration, black spots, and clouding of the silver film.

E. Design Criteria:

- 1. Labels:
 - a. Do not place names or labels on the exposed faces of accessories.
 - 1) On the interior surfaces not exposed to view, or on the back surface of each accessory, provide a printed, waterproof label or stamped nameplate indicating the manufacturer's name and the product model number.
- 2. Product Data:
 - a. Obtain the manufacturer's Product Data for the toilet and bath accessories, including construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, substrate preparation instructions, directions for preparing cutouts and installing anchoring devices, and the finishes for each type of accessory specified.



- b. Submit the manufacturer's Product Data for the toilet and bath accessories to the Program/Project Manager for approval.
- 3. Shop Drawings:
 - a. Prepare Shop Drawings for the toilet and bath accessories, including setting drawings and templates for the cutouts required in other work.

F. Materials:

- 1. Stainless Steel:
 - a. Unless otherwise indicated in the Contract Documents, provide stainless steel complying with the requirements for Type 304 having a No. 4 finish (satin) specified in ASTM A 666, and having a nominal thickness of at least 0.0312 inch (0.8mm).
- 2. Brass:
 - a. Provide brass complying with the requirements for leaded and unleaded flat products specified in ASTM B 19; for rods, shapes, forgings, and flat products with finished edges specified in ASTM B 16 (ASTM B 16M); and for castings specified in ASTM B 30.
- 3. Un-Galvanized Sheet Steel:
 - a. Provide un-galvanized sheet steel complying with the requirements for cold rolled, commercial quality steel specified in ASTM A 366/A 366M, and having a nominal thickness of at least 0.0359inch (0.9mm).
 - b. Provide un-galvanized sheet steel having prepared surfaces and metal pretreatments as required for the finish to be applied.
- 4. Galvanized Steel Sheet:
 - a. Provide galvanized steel sheet complying with the requirements for G60 (Z180) coatings specified in ASTM A 653/A 653M.
- 5. Chromium Plating:
 - a. Provide chromium plating complying with the requirements for nickel plus chromium electrodeposited on base metal specified for Service Condition Number SC 2 (moderate service) in ASTM B 456.
- 6. Baked-Enamel Finishes:
 - a. Provide factory-applied, gloss-white, baked-acrylic-enamel coatings.
- 7. Mirror Glass:
 - a. Provide mirror glass complying with the requirements specified in Commercial Item Description A-A-3002; and consisting of glass complying with the requirements for Type I (transparent flat glass), Class 1 (clear), Quality Q2 mirror glass specified in ASTM C 1036 with silvering, an electroplated copper coating, and a protective organic coating.
 - b. Provide annealed monolithic, silvered flat mirror glass having a nominal thickness of 6.0mm.
- 8. Mounting Devices:



- a. Provide steel mounting devices hot-dip galvanized after fabrication in accordance with the requirements specified in ASTM A 153/A 153M.
- 9. Fasteners:
 - a. Provide Screws, bolts, and other fastening devices fabricated from the same material as the accessory unit, that for exposed locations are tamper and theft resistant, and that for concealed locations are galvanized steel.

G. Equipment:

- 1. Paper Towel Dispensers (Tag Numbers PT and TA-46):
 - a. Provide a surface-mounted rolled paper towel dispenser fabricated using all welded construction from Type 304 stainless steel.
 - b. Provide a lever-less paper towel dispenser having a dispensing mechanism that dispenses a 12-onch length of towel each time the lever is pulled.
- 2. Jumbo Roll Toilet Tissue Dispensers - 9-Inch (Tag Number TP):
 - a. Provide surface mounted toilet tissue dispensers fabricated from high-impact, see through plastic, and having concealed anchorages.
 - b. Provide 9-Inch, one roll type toilet tissue dispensers designed to dispense toilet tissue from non-controlled 9-inch or 10-inch diameter-core jumbo tissue rolls mounted on the manufacturer's standard spindle.
- 3. Jumbo Roll Toilet Tissue Dispensers - 12-inch (Tag Number TA-44):
 - a. Provide surface mounted toilet tissue dispensers fabricated from stainless steel, and having concealed anchorages.
 - b. Provide 12-Inch, one roll type toilet tissue dispensers designed to dispense toilet tissue from non-controlled jumbo tissue rolls up to 12 inches in diameter mounted on the manufacturer's standard spindle.
- 4. Grab Bars - 1-1/4- Inch (Tag Numbers TA-01 through TA-06):
 - a. Provide stainless steel grab bars fabricated from 18 gauge, Type 304 stainless steel having a 1-1/4-inch outside diameter and a smooth, satin finish gripping surface.
 - b. Provide grab bars that are mounted using the manufacturer's standard anchors concealed by snap flange covers.
- 5. Grab Bars - 1-1/2- Inch (Tag Number GB):
 - a. For heavy-duty applications, provide stainless steel grab bars fabricated from Type 304 stainless steel that is at least 0.05 inch thick, has a 1-1/2-inch outside diameter, and a smooth, satin finish gripping surface.
 - b. Provide grab bars that are mounted using the manufacturer's standard anchors concealed by snap flange covers.
- 6. Sanitary Napkin Disposal Units (Tag Numbers SND):



- a. Partition-Mounted, Dual-Access Type (Tag Number SND):
 - 1) Provide stainless-steel sanitary napkin disposal units having adjustable flanges for partition mounting to serve two toilet compartments, a self-closing door, and a reusable receptacle that is removable from one side.
- b. Surface-Mounted Type (Tag Numbers SND and TA-45):
 - 1) Provide stainless-steel sanitary napkin disposal units having seamless exposed walls; a self-closing top cover; a locking bottom panel having a continuous stainless-steel hinge; and a removable, reusable receptacle.
7. Wall-Mounted Soap Dispensers (Tag Number SD):
 - a. Provide vandal resistant, wall-mounted, soap dispensers fabricated from stainless steel having a satin finish.
 - b. Provide soap dispensers having a vertical tank with at least a 40 fluid ounce capacity, and a corrosion-resistant valve that dispenses liquid and lotion soaps, and synthetic detergents.
 - c. Provide soap dispensers having hinged filler-tops that require a special key to open them.
8. Counter-Mounted Soap Dispensers (Tag Number TA-49):
 - a. Provide counter-mounted, touch-free, automatic soap dispensers that dispense one shot of soap from the dispenser when activated by sensors.
 - b. Provide counter-mounted soap dispensers that have a chrome finish.
9. Seat-Cover Dispensers (Tag Numbers SCD and TA-43):
 - a. Provide surface-mounted, stainless steel seat-cover dispensers having a concealed opening for filling at the bottom, and a capacity to hold at least 250 seat covers.
10. Mirrors (Tag Numbers MR and TA-71):
 - a. Provide mirror units having a frame fabricated from stainless steel angles having a nominal thickness of 0.05 inch, and capable of accommodating glass edge protection material.
 - b. Provide mirror units having square corners that are mitered, welded, and ground smooth.
 - c. Provide a mirror backing and support system that permits rigid, tamper-resistant glass installation, and prevents moisture accumulation.
 - 1) Provide galvanized steel backing sheet, not less than 0.034 inch (0.85mm) thick, and the full size of the mirror.
 - 2) Provide non-absorptive filler material; corrugated cardboard is not an acceptable filler material.
11. Mirror-Unit Hangers:



- 1) Provide a mirror-unit mounting system that permits rigid, tamper-resistant and theft-resistant installation as follows:
 - a) Provide one-piece, galvanized steel, wall-hanger devices having a spring-action locking mechanism that holds the mirror unit in position without exposed screws or bolts.
12. Folding Utility Shelves (Tag Number US):
 - a. Provide folding utility shelves having a spring loaded hinged shelf capable of automatically returning to the vertical position.
 - b. Provide folding utility shelves fabricated from stainless steel having a No. 4 finish (satin), and having a 15-inch long by 5-1/2-inch wide nominal size.
13. Waste Receptacles (Tag Number TA-47):
 - a. Provide surface-mounted waste receptacles fabricated from stainless steel with a satin finish, and having a removable heavy-gauge vinyl liner.
14. Seat-Cover and Toilet Tissue Dispensers (Tag Number TA-42):
 - a. Provide recessed type combination seat-cover and toilet tissue dispensers fabricated from stainless steel with a satin finish, and having a lockable door.
15. Combination Seat-Cover Dispenser, Sanitary Napkin Disposal, and Toilet Tissue Dispenser Units (Tag Number TA-40):
 - a. Provide recessed type combination seat-cover dispenser, sanitary napkin disposal, and toilet tissue dispenser fabricated from stainless steel with a satin finish, and having a lockable door.
16. Napkin/Tampon Vendors (Tag Number TA-41):
 - a. Provide recessed type sanitary napkin/tampon dispensers fabricated from stainless steel with a satin finish, and having a coin operated operating mechanism.
17. Hand Dryers (Tag Number TA-48):
 - a. Provide die-cast aluminum hand dryers having an anti-microbial scuff resistant lacquer coating on the exterior surfaces; and touch-free, infra-red activation.
18. Keys:
 - a. Provide universal keys that permit internal access to the accessories for servicing and resupplying.
 - b. Provide at least 6 keys to the Program/Project Manager for the Owner.

H. Fabrication:

1. Shop Fabrication:
 - a. Surface-Mounted Toilet Accessories:



- 1) Unless otherwise indicated in the Contract Documents, fabricate the toilet and bath accessory units so the seams and joints are tight, and the exposed edges are rolled.
- 2) Hang toilet and bath accessory doors and access panels using a continuous stainless-steel hinge.
- 3) Provide concealed anchorages where possible.
- b. Recessed Toilet Accessories:
 - 1) Unless otherwise indicated in the Contract Documents, fabricate toilet and bath accessory units using all-welded construction, without mitered corners.
 - 2) Hang toilet and bath accessory doors and access panels using full-length, stainless steel hinges.
 - 3) Provide anchorages that are fully concealed when the unit is closed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Verify the dimensions, tolerances, and method of attachment for the toilet and bath accessories with the other Work onsite.

B. Evaluation and Assessment:

1. Do not begin to install toilet and bath accessory until the openings and substrates have been properly prepared to receive the products provided under this Section.
2. If the substrate preparation is the responsibility of another installer, notify the Program/Project Manager of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the toilet and bath accessories.

B. Surface Preparation:

1. Prepare the substrate surfaces using the methods recommended by the toilet and bath accessory manufacturer for achieving the best result for the substrate under the Contract conditions.

C. Demolition/Removal:



1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install toilet and bath accessories in accordance with the manufacturers' written instructions, using fasteners recommended by the unit manufacturer and appropriate for the substrates encountered.
 1. Install toilet and bath accessories level, plumb, and firmly anchored in the locations and at the heights indicated in the Contract Documents.
- B. Mirrors:
 1. Secure mirrors to the walls using special concealed, tamper-resistant hangers, toggle bolts, or screws.
 2. Set mirror units level, plumb, and square at the locations indicated in the Contract Documents in accordance with the manufacturer's written instructions for the substrate encountered.

3.04 REPAIR/RESTORATION

- A. Replace damaged or defective toilet and bath accessory items with new undamaged toilet and bath accessories.

3.05 ADJUSTING

- A. Adjust the toilet and bath accessories so their operation is unencumbered and smooth, and verify that the mechanisms function properly.

3.06 CLEANING

- A. Remove temporary labels and protective coatings.
- B. Clean and polish exposed surfaces in accordance with the toilet and bath accessory manufacturer's written cleaning recommendations.
 1. Submit the toilet and bath accessory manufacturer's written cleaning recommendations to the Program/Project Manager for information.
- C. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.07 PROTECTION

- A. Protect installed toilet and bath accessory products until the Work of the Contract is completed.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
1. Furnish detailed maintenance data for the toilet and bath accessories, including lists of replacement parts and service recommendations, for inclusion in operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 2. Submit the maintenance data for the toilet and bath accessories to the Program/Project Manager for information.

3.09 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
1. Schedule 10801-1 Basis of Design Toilet and Bath Accessories.

END OF SECTION

Schedule 10801-1 Basis of Design Toilet and Bath Accessories			
Tag Number	Accessory Description	Manufacturer⁽¹⁾	Model Number⁽¹⁾
TA-01	Grab Bar with Snap Flange	Bobrick	B-5806 Series
TA-06			
GB	Grab Bar	Bobrick	B-6806 Series
TA-40	Seat-Cover Dispenser, Sanitary Napkin Disposal, and Toilet Tissue Dispenser Units	Bobrick	B-3574
TA-41	Napkin/Tampon Vendor	Bobrick	B-3500 Series
TA-42	Seat Cover and Toilet Tissue Dispenser	Bobrick	B-3474
SCD	Sear Cover Dispenser	Bobrick	B-221
TA-43			
TP	Toilet Paper Dispenser	Owner furnished	Contractor install



Schedule 10801-1 Basis of Design Toilet and Bath Accessories			
Tag Number	Accessory Description	Manufacturer ⁽¹⁾	Model Number ⁽¹⁾
TA-44	Toilet Paper Dispenser		
SND	Sanitary Napkin Disposal Unit	Bobrick	B-270
TA-45			
PT	Towel Dispenser	Bobrick	B-2869
TA-46	Roll Towel Dispenser	Bobrick	B-2860
TA-47	Waste Receptacle	Bobrick	B-275
TA-48	Hand Dryer	Murdock	Series 1118
SD	Wall-Mounted Soap Dispenser	Owner furnished	Contractor install
TA-49	Counter-Mounted Soap Dispenser	N/A	N/A
MR	Mirror with Angle Frame	Bobrick	B-290 2436
TA-71	Mirror	Bobrick	N/A
US	Folding Utility Shelf	Bobrick	B-287
1. Basis of design manufacturers and model numbers.			

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First Edition
1	12/20/2017	N/A	1.02.C.6, 1.04.B.1, 1.05.A.1, 2.01.C	Add requirements for ENVISION Sustainability Rating System





SECTION 11150

PARKING CONTROL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for modifications to the Phoenix Sky Harbor International Airport's Parking Revenue Control System (PRCS).
- B. Products Under This Section:
 - 1. Cashier booths, cashier fee computes, universal card devices, patron interface devices (PID), lane status lights, proximity card readers and their pedestals, ticket issuing machines, and parking barrier gate equipment on the Site, and indicated on the Contract Drawings, is to be installed or removed, relocated, and reinstalled under this Contract at the locations shown on the Contract Drawings.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 10432 - Exterior Electronic Message Signage.
 - 4. Section 11152 - Express Exit Stations.
 - 5. Section 11153 - Proximity Card Readers.
 - 6. Section 11154 - Embedded Preformed Loop Sensors.
 - 7. Section 11155 - Parking Barrier Gates.
 - 8. Section 11157 - License Plate Recognition Cameras.
 - 9. Section 13135 - Fabricated Tollbooths.
 - 10. Section 16120 - Conductors and Cables.
 - 11. Section 16123 - Control-Voltage Power Cables.
 - 12. Section 16712 - Communications Backbone Cabling.
 - 13. Section 16713 - Communications Horizontal Cabling.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AVI: Automated vehicle identification.
 - 2. CCI/CCO: Credit card in/credit card out.
 - 3. DIP: Dual In-line Package.
 - 4. ISF: Insufficient funds.
 - 5. LAT: Lane acceptance test.



6. LCIP: Lane control interface processor.
7. LPI: License plate inventory.
8. LPN: License plate number.
9. LPR: License plate recognition.
10. ODT: Operational demonstration test.
11. PC: Personal computer.
12. PID: Patron interface device.
13. PRCS: Parking revenue control system.
14. RFID: Radio frequency identification.
15. SAT: Site acceptance test.
16. TIM: Ticket issuing machine.

B. Definitions:

1. Automated Vehicle Identification (AVI): A technology whereby an RFID reader, focused on a specific drive lane, can detect and record passing vehicles that are equipped with an associated RFID transponder, such as a toll tag.
 - a. AVI technology can be integrated with other entry or exit lane equipment as a subsystem to a PRCS.
2. Cashier Station or Cashier Terminal: A PC-based PRCS device located in a staffed cashier booth at an exit lane that facilitates multiple methods of exit from a parking facility including ingesting and reading a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, or reading a proximity access card or contactless credit card.
 - a. The Cashier Station uses the data from the inserted or detected media to validate exit privileges or calculate and process the associated parking fee.
 - b. Fees can be paid via cash, check, validation, credit card, or contactless credit card; or exit may be granted via access card or validated/pre-paid magnetically encoded ticket.
3. Credit Card Keyfob: A keychain tag issued by credit card companies as a replacement for traditional credit cards.
4. Credit Card In/Credit Card Out (CCI/CCO): An express parking transaction whereby a patron inserts a credit card into an Entry Station to gain access into a parking facility, and upon exit the patron inserts the same credit card; the system matches the entry event with the exit event, calculates the appropriate parking fee, charges the credit card, and upon positive authorization of the credit card, the barrier gate raises and the patron exits the facility.
5. DIP Switches: A bank of miniature on-off switches mounted in computer hardware, such as on a circuit board or other device, and that holds



- configuration or setup information for that device. DIP switches are used to set the DMX address and mode of operation of electronic equipment.
6. Emergency Services Maintenance: Those maintenance services that are performed in response to specific events, and are usually intended to return equipment or an application to an operational status following such an event.
 7. Entry Station or Ticket Issuing Machine (TIM): A computerized PRCS device located in an entry lane that facilitates multiple methods of entry including issuing a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, receiving signals from an AVI antenna, reading a proximity access card, or reading a contactless credit card; commonly referred to as ticket issuing machine or TIM.
 8. Express Exit Station or Express Exit Terminal or Exit Verifier: A PC-based PRCS device located in an express exit lane that facilitates multiple methods of exit from a parking facility, including ingesting and reading a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, or reading a proximity access card or credit card fob via RFID.
 - a. The Exit Station uses the data from the inserted or detected media to validate exit privileges or calculate and process the associated parking fee.
 - b. Fees can be paid via credit card, or exit is granted via access card or validated/pre-paid magnetically encoded ticket.
 9. Insufficient Funds (ISF): An exception transaction that occurs when a patron does not have the means to satisfy payment of their parking fee.
 10. Keyfob: A plastic device, roughly the size of a car key, that works like a card having electronic circuitry that works with proximity card readers.
 11. Lane Acceptance Test (LAT): A test of a Contractor's installed equipment at the lane level to ensure that the equipment meets the intent of the Contract.
 12. Lane Control Interface Processor (LCIP): The processor used for communication between the parking revenue control system (PRCS) server and the lane equipment.
 13. License Plate Inventory (LPI): A combination of manual or automated processes that result in the accurate collection of the license plate numbers of all vehicles parked within a facility at the time the inventory is performed; a subsystem to a PRCS.
 14. Major Deviation: Any deviation or failure of a LAT, SAT, or ODT test procedure that affects fee calculation accuracy, transaction count



- accuracy, exception count accuracy, active ticket inventory accuracy (system vs. actual), revenue processing, calculations, or reporting.
15. Minor Deviation: Any deviation or failure of a LAT, SAT, or ODT test procedure that does not affect fee calculation accuracy, transaction count accuracy, exception count accuracy, active ticket inventory accuracy (system vs. actual), revenue processing, calculations, or reporting.
 16. Normal Conditions: Equipment malfunctions, parts usage under normal wear and tear, and performance of scheduled maintenance services.
 17. Normal Weather Conditions: Normal weather conditions are applicable to weather conditions that are common to the region such as rain, driving rain, strong thunderstorms, snow, sleet, or high winds.
 18. Operational Demonstration Test (ODT): A test of a fully installed PRCS to monitor the system during normal operating conditions, and ensure that the system is functional over a defined period of time in a manner consistent with the intent of the Contract.
 19. Operational Level Emergency Services Maintenance: Those emergency services maintenance procedures defined herein to be performed by the Owner's maintenance personnel.
 20. Operational Level Preventative Maintenance: Those preventative maintenance services defined herein to be performed by the Owner's maintenance personnel.
 21. Parking Revenue Control System (PRCS): A combination of equipment, software, subsystems, and supporting infrastructure that allows an entity to accurately calculate, collect, track, and report revenues for parking within one or more facilities.
 - a. A PRCS also monitors and controls ingress and egress to and from those facilities.
 22. Patron Interface Device (PID): A device installed on the sidewall of a cashier booth that facilitates multiple methods of exit from a parking facility including ingesting and reading a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, issuing credit card receipts, or reading a proximity access card or contactless credit card.
 - a. The PID also contains a screen which displays various messages to the patron to aid in their transaction as well as a ring-down, hands-free phone to communicate with parking operator personnel.
 23. Preventative Maintenance: Maintenance including but not limited to scheduled inspection, testing, necessary adjustment, alignments, lubrication, parts cleaning, replacement of consumables, communication system maintenance, server administration, database administration, and application support of the PRCS hardware and software.



24. Technician Level Emergency Services Maintenance: Those emergency services maintenance procedures defined herein to be performed by the Contractor.
25. Technician Level Preventative Maintenance: Those preventative maintenance services defined herein to be performed by the Contractor.

C. Reference Standards:

1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate installation of the Work of this Section with the contractor performing the work under Construction Package H03, and with the Program/Project Manager.
2. Coordinate with the Phoenix Sky Harbor International Airport as necessary to increase the available bandwidth to allow credit card authorizations for the parking revenue control system (PRCS) to be sent and returned as specified herein.

B. Sequencing:

1. Perform the Work of this Section in accordance with the Parking Revenue Control System (PRCS) Phasing sequence indicated on the Contract Drawings.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Modified Parking Revenue Control System (PRCS).
 - 2) Gate Equipment Layout

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:



- 1) Parking control equipment startup test records.
- b. Manufacturer's Instructions:
 - 1) Parking revenue control equipment manufacturers' instructions and recommendations.
- c. Source Quality Control Submittals:
 - 1) Copies of the manufacturers' performance, materials quality, and/or workmanship test records.
 - 2) Copies of the manufacturers' quality assurance inspection records.
- d. Site Quality Control Submittals:
 - 1) Parking control equipment startup test records.
- e. Manufacturer's Reports:
 - 1) Copies of the manufacturers' performance, materials quality, and/or workmanship test records.
 - 2) Copies of the manufacturers' quality assurance inspection records.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Comply with the requirements specified in the Phoenix Building Construction Code and Amendments and NFPA 70.
- B. Certifications:
 - 1. Electrostatic and Electromagnetic Force Certification:
 - a. Provide equipment that is UL-approved for use as part of a master labeled lightning protection system, and marked in accordance with UL procedures.
- C. Site Samples:
 - 1. Submit Sample photographs of the ticket issuing machine's active color matrix message screen to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver materials and equipment in a clean condition.
 - 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:



1. Handle materials and equipment in accordance with the manufacturer's written instructions.
2. Follow the manufacturer's written instructions for storing the items.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Provide equipment whose operation is not effected in any way by Normal Weather Conditions, and capable of normal operation under the following conditions:
 - a. Ambient Temperatures:
 - 1) Temperatures between -10 degrees Fahrenheit and 120 degrees Fahrenheit with the addition of solar loading.
 - b. Humidity:
 - 1) Humidity between 0 percent and 100 percent, non-condensing.
 - c. Rain:
 - 1) Blowing rain with 120 mph gusts of wind.
 - d. Dust:
 - 1) Blowing dust and fine sand
 - e. Radio Frequency Interference/Electromagnetic Interference (RFI/EMI):
 - 1) Provide equipment not affected by the standard RFI/EMI environment at the Phoenix Sky Harbor International Airport, and electromagnetically compatible with other equipment at the Airport, including radio frequency emissions.
 - a) Provide equipment not be susceptible to noise induced from the emissions of Electro Magnetic Interference (EMI) from high power radar, navigation aids, and radio equipment normally utilized at the Airport.

B. Existing Conditions:

1. An existing Parking Revenue Control System (PRCS) is in place at the Phoenix Sky Harbor International Airport, including a combination of equipment, software, subsystems, and supporting infrastructure that allows accurate calculation, collection, tracking, and reporting of parking revenues at the facility.
 - a. The PRCS monitors and controls ingress and egress to and from the facility parking areas.
 - b. The PRCS tracks revenue collection at parking areas.
 - c. Existing PRCS host servers may be inadequate to handle the additional parking control equipment provided under this Contract, and may need to be upgraded.



PART 2 PRODUCTS

2.01 PARKING CONTROL EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Scheidt & Bachmann, www.scheidt-bachmann.com.
 - b. Approved equal.
- B. Equipment Products:
 - 1. Owner-furnished cashier booths, cashier fee computes, universal card devices, patron interface devices (PID), lane status lights, proximity card readers and their pedestals, ticket issuing machines (TIM), and parking barrier gate equipment indicated in the Contract Documents to be removed, relocated, and reinstalled under this Contract are currently installed and functioning on the Site at the locations indicated on the Contract Drawings.
 - 2. Fabricated Tollbooths:
 - a. The fabricated tollbooths shall be furnished under Section 13135, Fabricated Tollbooths.
 - 3. Ticket Issuing Machine (TIM):
 - a. The PC-based ticket issuing machines (TIM) shall have the following features, components, and capabilities:
 - 1) Push-button ticket issue.
 - 2) Single-slot technology with the capability to provide all ticketing and card reading from a single slot in the Entry Station's face.
 - a) Capability to issue one credit card-sized, side-striped or center striped, magnetically encoded parking ticket for each entry transaction.
 - b) Capability to issue parking tickets uniquely encoded and printed for each specific parking area.
 - c) Ticket slots capable of reading International Standards Organization (ISO) standard side-stripe magnetically encoded cards, such as credit cards.
 - d) Mechanism capable of retracting tickets.
 - 3) A contactless credit card reader.
 - 4) A ring-down, hands-free intercom integrated into the face of the ticket issuing machine (TIM).
 - 5) An active color matrix message screen having a 6-inch minimum diagonal display that is easily readable under all ambient lighting conditions.
 - 6) A unique machine identification number.



- 7) A PC-based lane control interface processor (LCIP) to control equipment component communications within the lane and to the parking revenue control system (PRCS) server.
- 8) In the event that network communication is lost, capability to perform the following stand-alone functions:
 - a) Capable of storing all transactional information for a minimum of 1,800 offline transactions.
 - b) Capable of automatically shutting down in the event that the 1,800 transaction threshold is reached, and of remaining closed until the reestablishment of online communications.
 - c) Capable of automatically uploading all stored transaction information to the parking revenue control system (PRCS) server once communication is restored.
4. Lane Status Light:
 - a. The lane status lights shall be capable of displaying either the message "OPEN" or "CLOSED".
5. Cashier Fee Computer:
 - a. The cashier fee computers shall include a cashier drawer for transactions that require cashier intervention and a cashier terminal receipt printer.
6. Universal Card Device:
 - a. The universal card device is listed as "SL20", and shall perform similar functions to the express exit stations provided under Section 11152, Express Exit Stations.
7. Proximity Card Reader:
 - a. The proximity card readers shall be furnished under Section 11153, Proximity Card Readers.

2.02 SYSTEMS

A. Performance:

1. Entry Lane Equipment:
 - a. At the locations indicated on the Contract Drawings, provide or relocate entry lane equipment consisting of a lane status light indicating lane status; a parking barrier gate capable of providing or denying access to the parking area; embedded detector loops capable of detecting vehicular presence and acting as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; a license plate recognition camera capable of obtaining an image of a vehicle's license plate number; and a PC-based entry station consisting of a ticket issuing machine and a proximity card reader that are capable of facilitating multiple methods of entry



including issuing a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, receiving signals from an automated vehicle identification (AVI) antenna, reading a proximity access card, or reading a contactless credit card.

2. Express Exit Lane Equipment:

- a. At the locations indicated on the Contract Drawings, provide or relocate express exit equipment consisting of a dynamic message sign capable of displaying various lane and toll information; a parking barrier gate capable of providing or denying access to the parking area; embedded detector loops capable of detecting vehicular presence and acting as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; a license plate recognition camera capable of obtaining an image of a vehicle's license plate number; and a PC-based exit station consisting of a express exit station and a proximity card reader that are capable of facilitating multiple methods of exit from the parking facility, including ingesting and reading a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, reading a proximity access card, or reading a contactless credit card.
 - 1) Provide Express Exit Stations capable of using data from the inserted or detected media to validate exit privileges, or to calculate and process the associated parking fee.
 - 2) Provide Express Exit Stations capable of receiving parking fees paid via credit card, or granting exit via access card or validated/pre-paid magnetically encoded ticket.

3. Cashiered and ADA Cashiered Exit Lane Equipment:

- a. At the locations indicated on the Contract Drawings, provide or relocate cashiered and ADA cashiered exit equipment consisting of a dynamic message sign capable of displaying various lane and toll information; a parking barrier gate capable of providing or denying access to the parking area; embedded detector loops capable of detecting vehicular presence and acting as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; a license plate recognition camera capable of obtaining an image of a vehicle's license plate number; and a cashier booth containing a cashier fee computer and universal card reader that are capable of facilitating multiple methods of exit from the parking facility, including facilitating lost ticket exits, payment of cash or check fees, ingesting and reading a magnetically encoded parking ticket, or ingesting and reading a magnetically encoded access card or credit



card; and a proximity card reader capable of reading a proximity access card or credit card keyfob via RFID.

- 1) Cashiered toll booths additionally contain a patron interface device (PID).
 4. Parking Revenue Control System (PRCS) Processing Times:
 - a. Provide parking control equipment and subsystems capable of achieving the following allowable processing times:
 - 1) Report Generation:
 - a) For Data Less Than 6 Months Old: Less than 5 seconds.
 - b) For Data 6 Months or Older: Less than 15 seconds.
 - 2) Credit Card Authorizations:
 - a) Provide a system having a speed of connection capable of sending and returning authorizations in 4 seconds or less, even at peak times and accounting for a 150 percent increase in transactions.
 5. Parking Revenue Control System (PRCS) Accuracy:
 - a. Provide parking control equipment and subsystems that deliver the following accuracy:
 - 1) Fee Calculation: 100.0 percent accurate.
 - 2) Transaction Counts: 100.0 percent accurate.
 - 3) Exception Counts: 100.0 percent accurate.
 - 4) Active Ticket Inventory (System Versus Actual): 100.0 percent accurate.
 - 5) Revenue Processing: 100.0 percent accurate.
 - 6) Calculations: 100.0 percent accurate.
 - 7) Reporting: 100.0 percent accurate.
- B. Design Criteria:
1. Design the Parking Revenue Control System (PRCS) to not only use the industry's latest technological advancements to control access and revenue for the parking facilities, but to improve the overall management, system efficiency, revenue accounting, revenue security, and customer service aspects of the parking operations at the Phoenix Sky Harbor International Airport (PSHIA).
 - a. Except where otherwise indicated in the Contract Documents, provide only newly manufactured equipment and associated materials for the Parking Revenue Control System (PRCS).
 - 1) Do not provide used or refurbished equipment and associated materials unless otherwise indicated in the Contract Documents.
 - b. For all lane equipment that performs a like function, provide similar equipment having the same part number and that is fully



- interchangeable without needing physical modifications other than setting DIP switches to select a specific function.
2. Implement hardware and application software that will meet or exceed the PSHIA's Parking Revenue Control System (PRCS) needs for at least 10 years after the system's final acceptance.
 3. Provide a parking control system designed to calculate parking fees based upon the different parking facilities, lengths of stay, time increments, and rate structures.
 4. Provide equipment that supports remote monitoring of distributed units.
 5. Design the Parking Revenue Control System (PRCS) so environmental conditions do not inhibit the PRCS from performing in accordance with the Contract requirements.
 - a. Provide a system so environmental conditions in a cabinet do not cause failure of the installed electronics.
 - b. Provide external heating and/or cooling devices necessary to achieve the required operability.
 - c. Design individual units so they shut down in the event that temperatures become too extreme so damage to the unit's electronics would otherwise result.
 6. Design the Parking Revenue Control System (PRCS) so electrostatic and electromagnetic forces within the environment, such as non-direct lightning strikes, or other types of power interference, have no effect upon the integrity or operation of the PRCS.
 - a. Provide lightning protection through surge arrestors or earthen ground rods or a combination thereof for the PRCS.
 - b. Based upon system requirements, determine the appropriate lightning protection method to use for the location where the equipment is installed.
 - c. Prior to implementing the proposed solution for preventing power interference, submit the design, including Product Data and Shop Drawings, to the Program/Project Manager for approval.
 7. Shop Drawings:
 - a. Provide Shop Drawings of the modified Parking Revenue Control System (PRCS) provided under this Contract, including wiring diagrams, control sequences, and dimensioned equipment location drawings.
 - 1) Indicate how the new and relocated equipment will be integrated into the existing system.

C. Operation:

1. Operators:



- a. Provide equipment operators as specified in Section 10432, Exterior Electronic Message Signage, Section 11152, Express Exit Stations, Section 11153, Proximity Card Readers, Section 11154, Embedded Preformed Loop Sensors, Section 11155, Parking Barrier Gates, Section 11157, License Plate Recognition Cameras, and Section 13135, Fabricated Tollbooths.
2. Controls:
 - a. Provide controls as specified in Section 10432, Exterior Electronic Message Signage; Section 11152, Express Exit Stations; Section 11153, Proximity Card Readers; Section 11154, Embedded Preformed Loop Sensors; Section 11155, Parking Barrier Gates; Section 11157, License Plate Recognition Cameras; Section 13135, Fabricated Tollbooths; and .as exist in the existing parking revenue control system (PRCS).
3. Operation Sequences:
 - a. Public Entry Procedure for All Entry Events:
 - 1) The following operation sequence applies to all public entry events:
 - a) As a vehicle approaches an entry lane, a lane status light indicates the lane's status as either "OPEN" or "CLOSED".
 - b) When the entry lane arming loops are not activated, the Entry Station's ticket issuing machine displays the message, "Phoenix Sky Harbor International Airport", and displays the time.
 - c) When the vehicle activates the arming loops, the Entry Station's ticket issuing machine displays the message "Press Button for Ticket or Insert/Swipe Credit Card".
 - d) After each valid entry, the entry barrier gate's closing detector device detects the presence of the vehicle.
 - (1) The lane's license plate recognition camera takes an image of the vehicle's license plate, and submits it to the parking revenue control system (PRCS) for processing and subsequent storage in the system license plate inventory (LPI).
 - (2) Upon clearing the barrier gate's closing detector, the barrier gate arm lowers to the closed position and the lane's equipment is automatically reset for a subsequent transaction.
 - e) The entry event is validated, and the data associated with the entry event is stored.
 - b. Public Entry Procedures That Are Transaction Specific:



- 1) In addition to the public entry procedures listed in Subparagraph 2.02.C.3.a, the following transaction specific procedures also apply when the specific circumstances indicated are to occur:
 - a) Normal Entry with a Ticket:
 - (1) When a patron presses the ticket issue button on the ticket issuing machine, no other entry method will then be allowed, and the Entry Station ticket issuing machine issues a uniquely numbered parking ticket while an audible signal is sounded.
 - (a) In this case, the Entry Station ticket issuing machine magnetically encodes and prints the year, month, date, entry time (hour/minute/second), facility code, lane number, entry sequence number, unique transaction number, and unique machine number on the ticket.
 - (b) Abbreviations are acceptable.
 - (c) Time stamps must be encoded and printed in 24-hour, military time.
 - (2) When the printed/encoded ticket is extracted from the Entry Station ticket issuing machine, the audible signal ceases, the ticket issuing machine display reads "Welcome to Phoenix Sky Harbor International Airport", and the barrier gate rises to the open position to allow the vehicle to enter the parking facility.
 - b) Normal Entry with a Credit Card:
 - (1) When a patron inserts or swipes a credit card as their entry credential, no other entry method will then be allowed, and the Entry Station ticket issuing machine must read the credit card and verify that the card is valid.
 - (2) After a standard credit card is inserted, the card must be returned to the patron through the ticket issuing machine's ticket throat while an audible signal is sounded.
 - (3) After the patron retrieves their credit card, the audible signal must cease, the ticket issuing machine display must read "Welcome to Phoenix Sky Harbor International Airport", and the barrier gate must rise to the open position to allow the vehicle to enter the parking facility.
 - c) Back Out at Entry:
 - (1) If a patron pushes the ticket issue button on the ticket issuing machine and backs out of the lane without retrieving the ticket, the barrier gate must remain closed



- and the ticket must be retracted and retained in the ticket issuing machine.
- (a) The back out entry event must be stored in the system, and the lane must automatically reset for a subsequent transaction.
 - (b) The ticket must be invalidated within the system.
- d) Stolen Ticket at Entry:
- (1) If a patron pushes the ticket issue button on the ticket issuing machine, retrieves the ticket, and then backs out of the lane the barrier gate must automatically return to the closed position, the ticket must be invalidated in the system, and an alarm must be generated.
 - (a) The stolen ticket entry event must be stored in the system.
 - (b) The ticket must be electronically invalidated and must not be allowed to be processed at any exit.
- c. Public Exit Procedures for Express Exit Lanes:
- 1) The following operation sequence applies to public exit events at Express Exit Lanes:
 - a) As the vehicle approaches the Express Exit Lane at the common exit plaza, the overhead dynamic message signage displays the appropriate message and/or graphics.
 - b) When the Express Exit Lane arming loops are not activated, the Express Exit Lane Station's display reads, "Phoenix Sky Harbor International Airport", and displays the time; or displays an alternate, Owner-approved message.
 - c) When the vehicle activates the arming loops, the Express Exit Lane Station's display alternates between the showing the messages, "Insert Ticket" and "Or Insert/Swipe Credit Card Used at Entry"; or displays an alternate, Owner-approved message.
 - (1) The lane's license plate recognition camera takes an image of the vehicle's license plate, and submits it to the parking revenue control system (PRCS) for processing and comparison with the system license plate inventory (LPI).
 - d) After the appropriate exit credential is either inserted into or swiped at the express exit station, the express exit lane's dynamic message signage displays the message, "Processing, Please Wait"; or displays an alternate, Owner-approved message.



- (1) Once positive verification of the entry and exit data occurs, the display shows the fee due.
 - (a) For credit card in/credit card out (CCI/CCO) transactions, the credit card authorization automatically begins.
 - (b) For ticket transactions, the display shows the message, "Insert/Swipe Credit Card for Payment"; or displays an alternate, Owner-approved message
- (2) During credit card authorization, the display shows the message "Processing, Please Wait"; or displays an alternate, Owner-approved message.
- e) Once the credit card is inserted and if payment is obtained, the credit card is returned through the ticket slot and the display shows the message "Please Take Credit Card"; or displays an alternate, Owner-approved message.
- f) When the credit card is removed, the station prints the patron's receipt, the display shows the message, "Please Take Receipt" or displays an alternate, Owner-approved message, and the station produces an audible "beep".
- g) After the receipt is taken, the audible "beep" ceases and the barrier gate rises.
- h) After the vehicle crosses the closing loop, the barrier gate closes and the lane resets for the next transaction.
- i) The ticket is moved from active ticket inventory to inactive ticket inventory, and the associated license plate recognition (LPR) image is moved from active to inactive inventory.
- d. Public Exit Procedures for Express Exit Lanes That Are Transaction Specific, or for Abnormal or Unique Events:
 - 1) In addition to the public exit procedures listed in Subparagraph 2.02.C.3.c, the following transaction specific procedures also apply when the specific circumstances indicated are to occur:
 - a) Invalid Credit Card Presented for Payment:
 - (1) After the fee is displayed and an invalid credit card is swiped at the express exit station, the express exit lane displays the message, "Processing, Please Wait" or displays an alternate, Owner-approved message.
 - (2) Once authorization of the credit card is declined, the credit card is returned through the ticket slot and the display shows the message "Card Not Approved, Please Try a Different Credit Card" or displays an alternate, Owner-approved message.



- (3) After the invalid credit card is removed, the ticket remains in the express exit station and the display alternates between showing the fee and the message "Insert/Swipe Credit Card for Payment" or displays an alternate, Owner-approved message.
- (4) Once the patron presents a valid credit card for payment, the transaction continues as a normal exit transaction.
- (5) If the patron does not have a valid credit card, the patron must push the ring-down, hands-free phone for assistance.
- b) Exit Within Grace:
 - (1) If positive verification of the ticket data occurs, a zero dollar fee is displayed and the barrier gate rises.
 - (2) Once the gate rises, the transaction continues as a normal exit transaction.
- c) Lost Ticket Transaction:
 - (1) Patrons losing their parking tickets must proceed to an attended cashier lane to inform the cashier that the patron's parking ticket has been lost.
 - (2) After the patron informs the cashier that the ticket has been lost, the cashier retrieves the patron's entry information based on the license plate recognition (LPR) data.
 - (a) If the patron's entry data can be determined, then the cashier manually enters the entry date and time; and the correct fee is calculated, displayed, and collected.
 - (b) If no entry data can be found, then the patron is charged a lost ticket fee.
- d) Unreadable Ticket Transaction:
 - (1) If after the parking ticket is inserted into the express exit station the ticket cannot be read by the express exit station, then the parking ticket is returned to the patron through the ticket slot.
 - (2) The Express Exit Lane displays the message, "Ticket Unreadable, Please Proceed to a Cashiered Lane for Assistance" or displays an alternate, Owner-approved message.
 - (3) Patrons having unreadable parking tickets must proceed to an attended cashier lane for assistance.
- e) Attempt to Exit with Stolen Ticket:



- (1) If after the parking ticket is inserted into the express exit station the ticket is identified as a stolen ticket, the system generates an appropriate alarm and the express exit lane displays the message, "Ticket Invalid, Please Proceed to a Cashiered Lane for Assistance" or displays an alternate, Owner-approved message.
- (2) Patrons having stolen parking tickets must proceed to an attended cashier lane for assistance.
- f) Exit with Validation:
 - (1) After the Express Exit Lane displays the parking fee, a validation is inserted into the ticket slot of the express exit station.
 - (2) Based on the type of validation, the express exit station applies the discount to the parking fee due, and updates the Express Exit Lane's display to show the reduced fee due.
 - (a) If the entire parking fee due is validated, then the barrier gate rises and the transaction continues as a normal transaction.
 - (b) If the validation does not satisfy the entire parking fee, the patron must present a credit card for payment and the transaction continues as a normal transaction.
- e. Public Exit Procedures for Cashiered Exit Lanes:
 - 1) Transactions processed at an unmanned Cashiered Exit Lane follow the same procedures as those for transactions at an Express Exit Station as specified herein.
 - 2) At manned Cashiered Exit Lanes, the cashier drawer must only open for those transactions that require cashier intervention such as cash transactions, check transactions, and similar operations.
 - a) For transactions at manned Cashiered Exit Lanes that do not require cashier intervention, such as credit card transactions, grace tickets, validation transactions, and other similar transactions, the cashier drawer must remain closed.
 - 3) For normal transactions at manned Cashiered Exit Lanes, the following operation sequences and procedures apply:
 - a) As a vehicle approaches the Cashiered Exit Lane the dynamic message signage display shows the appropriate message and/or graphics.
 - (1) When the Cashiered Exit Lane arming loops are not activated, the Cashiered Exit Lane's display shows the message, "Phoenix Sky Harbor International Airport", and



- displays the time, or displays an alternate, Owner-approved message.
- (2) When the vehicle activates the arming loops, the Cashiered Exit Lane alternately displays "Insert Ticket" and "Or Insert/Swipe Credit Card Used at Entry", or displays an alternate, Owner-approved message.
 - (a) The lane's license plate recognition camera takes an image of the vehicle's license plate, and submits it to the parking revenue control system (PRCS) for processing and comparison with the system license plate inventory (LPI).
 - b) After the appropriate exit credential is either inserted into or swiped at the Cashiered Exit Lane's patron interface device (PID), verification of the entry time takes place and the message, "Processing, Please Wait" or an alternate, Owner-approved message, is displayed on the Cashiered Exit Lane's patron interface device (PID) and on the cashier terminal.
 - (1) Once positive verification of the entry data occurs, the patron interface device (PID) and the cashier terminal display the parking fee due.
 - (2) After the parking fee is satisfied, the patron's receipt is printed through the cashier terminal receipt printer and given to the patron, and the barrier gate rises.
 - c) When the vehicle crosses the closing loop, the barrier gate closes and the station resets for the next transaction.
 - d) The ticket is moved from the active ticket inventory to the inactive ticket inventory, and the associated license plate recognition (LPR) image is moved from active to inactive inventory.
- 4) Public Exit Procedures for Cashiered Exit Lanes That Are Transaction Specific:
- a) Exit with a Ticket and Credit Card Payment:
 - (1) After the patron interface device (PID) and the cashier terminal display the parking fee due, the patron inserts a credit card in the patron interface device (PID) ticket slot or swipes a credit card over the contactless credit card reader, and the screen on the Cashiered Exit Lane's patron interface device (PID) displays the message "Processing, Please Wait" or displays an alternate, Owner-approved message.



- (2) Once the credit card is inserted and if payment is authorized, the credit card is returned through the ticket slot and the patron interface device (PID) displays the message "Please Take Credit Card" or displays an alternate, Owner-approved message.
 - (a) A message is displayed on the cashier terminal to inform the cashier that the payment was successfully processed.
- (3) When the credit card is removed, the cashier terminal receipt printer prints the patron's receipt, and a button appears on the cashier terminal to confirm that the patron has received their receipt.
- (4) The cashier gives the patron the receipt, and presses a button confirming that the patron has received their receipt.
- (5) After the cashier presses the button confirming that the patron has received their receipt, the barrier gate rises and the transaction continues as a normal transaction.
- b) Exit with a Ticket and Check Payment:
 - (1) After the patron interface device (PID) and the cashier terminal display the parking fee due, the cashier presses the check button on the cashier terminal, then the cash drawer opens.
 - (2) The cashier places the check in the drawer and closes the cash drawer.
- c) Exit with a Ticket and Cash Payment:
 - (1) After the patron interface device (PID) and the cashier terminal display the parking fee due, the cashier presses the cash button on the cashier terminal and inputs the amount received from the patron, then the cash drawer opens and the change due to the patron is displayed on the PID and the cashier terminal.
 - (2) The cashier places the cash received in the drawer and makes change, the receipt is printed on the cashier terminal, and the cashier gives the receipt to the patron and closes the cash drawer.
 - (3) After the cash drawer is closed, the barrier gate rises and the transaction continues as a normal transaction.
- d) Exit with a Credit Card (CCI/CCO):
 - (1) After approaching the patron interface device (PID), the patron inserts or swipes the same credit card used at



- entry, and the license plate recognition (LPR) system verifies the ticket information.
- (a) While entry verification is taking place, the cashier terminal and the patron interface device (PID) display the message "Processing, Please Wait" or displays an alternate, Owner-approved message.
 - (b) Once ticket data is matched, the correct fee is displayed on the PID and the cashier terminal.
- (2) While the credit card authorization is taking place, the patron interface device (PID) displays the message "Processing, Please Wait" and the fee due, or displays an alternate, Owner-approved message.
- (3) Once credit card authorization is obtained, the credit card is returned through the ticket slot and the patron interface device (PID) displays the message, "Please Take Credit Card" or displays an alternate, Owner-approved message.
- (a) A message is displayed on the cashier terminal to inform the cashier that the payment was successfully processed.
- (4) When the credit card is removed, the cashier terminal receipt printer prints the patron's receipt, and a button appears on the cashier terminal to confirm that the patron has received their receipt.
- (5) The cashier gives the patron the receipt, and presses a button confirming that the patron has received their receipt.
- (6) After the cashier presses the button confirming that the patron has received their receipt, the barrier gate rises and the transaction continues as a normal transaction.
- e) Invalid Credit Card Presented for Payment:
- (1) After approaching the patron interface device (PID), the patron inserts or swipes the same credit card used at entry, and the license plate recognition (LPR) system verifies the ticket information.
 - (a) While entry verification is taking place, the cashier terminal and the patron interface device (PID) display the message "Processing, Please Wait" or displays an alternate, Owner-approved message.
 - (b) Once ticket data is matched, the correct fee is displayed on the PID and the cashier terminal.



- (2) While credit card authorization is being requested, the patron interface device (PID) must display the message "Processing, Please Wait" and the fee due, or displays an alternate, Owner-approved message.
 - (3) Once authorization is declined, the credit card is returned through the ticket slot and the patron interface device (PID) displays the message "Card Not Approved, Please Try a Different Credit Card" and the parking fee due or displays an alternate, Owner-approved message.
 - (4) Once the patron inserts a valid credit card for payment, the transaction continues as a normal exit transaction.
- f) Exit Within Grace:
- (1) If positive verification of the ticket data occurs, a zero dollar fee is displayed on the patron interface device (PID) and the cashier terminal.
 - (2) A message is displayed on the cashier terminal to inform the cashier that the ticket is a grace ticket, and a button appears for the cashier to confirm the transaction.
 - (3) After the cashier presses the button confirming the transaction, the barrier gate rises.
 - (4) Once the gate rises, the transaction continues as a normal exit transaction.
- g) Lost Ticket Transaction:
- (1) After the patron informs the cashier that he or she has lost his or her ticket, the cashier presses a lost ticket button on the cashier terminal.
 - (a) A supervisor, able to use the license plate recognition (LPR) system, attempts to verify the patron's entry information based on the LPI data.
 - (b) While the supervisor's license plate recognition (LPR) system license plate verification is taking place, the message, "Processing, Please Wait", or an alternate, Owner-approved message is displayed on the patron interface device (PID).
 - (2) If the entry information can be determined, then the cashier enters the entry information into the Cashier Station, the correct fee is calculated and displayed on the patron interface device (PID) and cashier terminal, and the transaction continues as a normal transaction.
 - (3) If the entry information cannot be determined, then the patron is charged a lost ticket fee.



- (4) An exception ticket is generated for the lost ticket, and is retained for audit purposes.
- h) Unreadable Ticket Transaction:
 - (1) If after the parking ticket is inserted into the patron interface device (PID) the ticket cannot be read, then the parking ticket is returned to the patron through the ticket slot.
 - (2) The patron interface device (PID) and cashier terminal display the message, "Ticket Unreadable" or displays an alternate, Owner-approved message.
 - (3) The cashier presses an unreadable ticket button on the cashier terminal, and is then prompted to manually enter the entry information from the parking ticket.
 - (4) After the entry information is manually entered, the correct fee is calculated and displayed on both the patron interface device (PID) and the cashier terminal, and the transaction continues as a normal transaction.
 - (5) The system generates an exception ticket for the unreadable ticket, which is retained along with the original unreadable ticket for audit purposes.
- i) Insufficient Funds (ISF) Transaction:
 - (1) If, after the parking fee is displayed, the patron informs the cashier that he or she does not have sufficient funds to satisfy the parking fee, the cashier presses the insufficient funds (ISF) button on the cashier station, and a screen mask appears.
 - (2) If the patron is able to pay part of the parking fee, then that amount is collected by the cashier and deducted from the outstanding fee due.
 - (3) The cashier requests identification credentials from the patron; and at a minimum enters the patron's first name, last name, driver's license number, home address, and vehicle license plate number (LPN).
 - (4) The receipt printer prints an insufficient funds (ISF) form, and the patron must sign and return it to the cashier.
 - (5) Upon acknowledgement that the insufficient funds (ISF) form is received, the receipt printer prints a copy of the ISF form for the patron and the transaction continues as a normal transaction.
- j) Attempt to Exit with Stolen Ticket:



- (1) If after the parking ticket is inserted into the patron interface device (PID) the ticket is identified as a stolen ticket, then an appropriate alarm is generated by the system, and the message "Invalid Ticket" or displays an alternate, Owner-approved message is displayed on the patron interface device (PID) and cashier terminal.
 - (2) The cashier presses an invalid ticket button on the cashier terminal.
 - (a) A supervisor, alerted by the stolen ticket alarm, verifies that the transaction is a stolen ticket.
 - (3) The stolen ticket transaction is then processed as a lost ticket transaction.
 - (4) The system generates an exception ticket, which is retained with the stolen ticket for audit purposes.
 - (5) After payment is received, the transaction continues as a normal transaction.
- k) Exit with a Validation:
- (1) If after the patron interface device (PID) and the cashier terminal display the parking fee due a validation is inserted into the ticket slot, then the appropriate discount is applied to the parking fee due based on type of validation.
 - (2) The patron interface device (PID) and the cashier terminal displays update to show the reduced fee due.
 - (3) If the entire fee due is validated, then the barrier gate rises and the transaction continues as a normal transaction.
 - (4) If the validation does not satisfy the entire parking fee, the patron must present an acceptable form of payment and the transaction continues as a normal transaction.

D. Materials:

1. Dynamic Message Signage:
 - a. Provide dynamic message signage complying with the requirements specified in Section 10432, Exterior Electronic Message Signage.
2. Express Exit Stations:
 - a. At the locations indicated on the Contract Drawings, provide PC-based Express Exit Stations complying with the requirements specified in Section 11152, Express Exit Stations.
3. Fabricated Tollbooths:
 - a. Provide fabricated tollbooths complying with the requirements specified in Section 13135, Fabricated Tollbooths.



4. License Plate Recognition Cameras:
 - a. Provide license plate recognition cameras complying with the requirements specified in Section 11157, License Plate Recognition Cameras.
5. Loop Sensors:
 - a. Provide loop sensors complying with the requirements specified in Section 11154, Embedded Preformed Loop Sensors.
6. Parking Barrier Gates:
 - a. Provide new parking barrier gates complying with the requirements specified in Section 11155, Parking Barrier Gates.
7. Proximity Card Readers:
 - a. At the locations indicated on the Contract Drawings, provide proximity card readers and associated pedestals complying with the requirements specified in Section 11153, Proximity Card Readers.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Manufacturer's Tests:
 - a. Test Procedure:
 - 1) Prior to the start of installation, the parking control equipment must undergo the manufacturer's formal product testing.
 - 2) Maintain records of the manufacturers' performance, materials quality, and/or workmanship tests.
 - b. Acceptance Criteria:
 - 1) The parking control equipment must successfully pass the manufacturer's formal testing and quality assurance inspections to validate compliance with this Contract.
 - a) Prior to the start of installation, submit copies of the manufacturers' performance, materials quality, and/or workmanship test records to the Program/Project Manager for approval.
 2. Inspections:
 - a. The parking control equipment must undergo and pass the manufacturer's quality assurance inspections.
 - 1) Prior to the start of installation, submit copies of the manufacturers' quality assurance inspection records to the Program/Project Manager for approval.
- B. Non-Conforming Work:
 1. Should reliability become a problem at any time from the beginning of installation testing through the final operational test period, submit proof of



product reliability analysis and testing to the Program/Project Manager for approval

- a. Due to the importance of maintaining the system in an operational status and financial management, product reliability is of significant importance.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the areas to receive the parking control equipment have been properly prepared to receive the equipment.
- B. Evaluation and Assessment:
 1. Prior to installing the Work of this Section, verify that the work performed under Construction Package H03 related to installation of the parking control equipment provided under this Contract has been satisfactorily completed.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Surface Preparation:
 1. Properly level the areas to receive the fabricated tollbooths.
- C. Demolition/Removal:
 1. Remove, relocate, and reinstall the existing Parking Revenue Control System (PRCS) equipment as indicated on the Contract Drawings.

3.03 INSTALLATION

- A. Install and/or remove, relocate, and reinstall the parking control equipment at the locations and in accordance with the Phasing indicated on the Contract Drawings to provide fully functional and operational equipment integrated into the Phoenix Sky Harbor International Airport's Parking Revenue Control System (PRCS).
 1. Lane Arming Loops, License Plate Recognition (LPR) Trigger Loops, and Barrier Gate Closing Detectors:



- a. Install embedded preformed loop sensors to perform as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors.
- B. Install the parking revenue control equipment in accordance with the manufactures instructions and recommendations.
 - 1. Submit the parking revenue control equipment manufacturers' instructions and recommendations not provided under other Sections for equipment to the Program/Project Manager for information.
- C. Entry Stations:
 - 1. At the locations indicated on the Contract Drawings, install PC-based entry lane equipment consisting of a lane status lights, ticket issuing machines (TIM) , loop sensors to perform as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors, proximity card readers, parking barrier gates, and infrared license plate recognition cameras.
 - a. Entry Lane Vehicle Detection:
 - 1) Provide entry lane vehicle detectors capable of detecting vehicular presence, legal entry, illegal exit, and back-out.
 - b. Install the equipment indicated as Owner-furnished equipment to be relocated on the Contract Drawings.
 - c. Furnish and install the new equipment that is not indicated as Owner-furnished on the Contract Drawings.
- D. Express Exit Lanes:
 - 1. At the locations indicated on the Contract Drawings, provide dynamic message signs and PC-based express exit lane equipment consisting of express exit stations; loop sensors to perform as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; proximity card readers; parking barrier gates; and infrared license plate recognition cameras:
 - a. Exit Lane Vehicle Detection:
 - 1) Provide exit lane vehicle detectors capable of detecting vehicular presence, legal exit, illegal exit, and back-out.
 - b. Install the equipment indicated as Owner-furnished equipment to be relocated on the Contract Drawings.
 - c. Furnish and install the new equipment indicated as not Owner-furnished on the Contract Drawings.



E. Cashiered Exit Lanes:

1. At the locations indicated on the Contract Drawings, provide dynamic message signs and PC-based cashiered exit lane equipment consisting of cashier booths; cashier fee computers; universal card devices; loop sensors to perform as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; proximity card readers; parking barrier gates; patron interface devices (PID); and infrared license plate recognition cameras:
 - a. Exit Lane Vehicle Detection:
 - 1) Provide exit lane vehicle detectors capable of detecting vehicular presence, legal exit, illegal exit, and back-out.
 - b. Install the equipment indicated as Owner-furnished equipment to be relocated on the Contract Drawings.
 - c. Furnish and install the new equipment indicated as not Owner-furnished on the Contract Drawings.

F. ADA Cashiered Exit Lanes:

1. At the locations indicated on the Contract Drawings, provide dynamic message signs and PC-based ADA cashiered exit lane equipment consisting of cashier booths; cashier fee computers; universal card devices; loop sensors to perform as lane arming loops, license plate recognition (LPR) trigger loops, and barrier gate closing detectors; proximity card readers; parking barrier gates; and infrared license plate recognition cameras:
 - a. Exit Lane Vehicle Detection:
 - 1) Provide exit lane vehicle detectors capable of detecting vehicular presence, legal exit, illegal exit, and back-out.
 - b. Install the equipment indicated as Owner-furnished equipment to be relocated on the Contract Drawings.
 - c. Furnish and install the new equipment indicated as not Owner-furnished on the Contract Drawings.

G. Interface with Other Work:

1. Make the electrical and control connections required to provide complete and operational Parking Revenue Control System (PRCS).
 - a. Provide electrical and control conductors and cables complying with the requirements specified in Section 16120, Conductors and Cables, Section 16123, Control-Voltage Power Cables, Section 16712, Communications Backbone Cabling, and Section 16713, Communications Horizontal Cabling.



H. Systems Integration:

1. Integrate the parking revenue control equipment provided and/or installed under this Contract with the existing Parking Revenue Control System (PRCS) is in place at the Phoenix Sky Harbor International Airport.
 - a. Connect the status lights to the loop detector circuits.
 - b. Connect the ticket issuing machines (TIM) to the Parking Revenue Control System (PRCS) host server conductors.
 - c. Connect the cashier booths to the Parking Revenue Control System (PRCS) host server conductors.
 - d. Connect the cashier fee computers to the Parking Revenue Control System (PRCS) host server conductors.
 - e. Connect the universal card devices to the Parking Revenue Control System (PRCS) host server conductors.
 - f. Connect the express exit stations to the Parking Revenue Control System (PRCS) host server conductors.
 - g. Connect the express exit stations to the Parking Revenue Control System (PRCS) intercom system.
 - h. Connect the proximity card readers to the Parking Revenue Control System (PRCS) host server conductors.
 - i. Connect the license plate recognition cameras to the Parking Revenue Control System (PRCS) host server conductors.
 - 1) Install the license plate recognition software on the parking revenue control system (PRCS) host servers as required to provide the license plate inventory (LPI) as defined herein.
 - j. Connect the exterior dynamic message signs to the appropriate host server conductors.
 - 1) Install the exterior dynamic message sign software on the appropriate host servers or workstation as required to provide the functionality specified in Section 10432, Exterior Electronic Message Signage.
 - k. Make the control connections required to provide complete and operational parking barrier gate systems.

3.04 REPAIR/RESTORATION

- A. Repair or replace Parking Revenue Control System (PRCS) equipment and dynamic signs damaged during removal, salvage, transport, installation, and/or re-installation.
- B. Restore the areas where existing Parking Revenue Control System (PRCS) equipment has been removed, and leave these areas in a safe condition.
 1. De-energize abandoned power lines.



2. Fill open excavations.

3.05 RE-INSTALLATION

- A. Relocate and reinstall the salvaged Owner-furnished Parking Revenue Control System (PRCS) equipment on the Site at the locations shown and according to the Phasing information indicated on the Contract Drawings,.

3.06 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Perform startup testing and inspections as specified in Article 3.07.
- B. Non-Conforming Work
 1. Parking Revenue Control System (PRCS) equipment that is not properly connected, and in working order, is unacceptable.
- C. Manufacturer Services:
 1. After installation of the parking revenue control equipment, arrange for technical personnel from the manufacturer to be onsite to verify that the equipment is functioning properly by testing the equipment.

3.07 SYSTEM STARTUP

- A. After all of the Parking Revenue Control System (PRCS) equipment, whether new or relocated, has been installed or reinstalled, startup the various completed systems to verify that the complete system is operational and functions as specified herein.
 1. Ensure that the Operation and Maintenance manuals for the equipment to be tested have been submitted to the Program/Project Manager prior to the testing.
- B. Perform the following startup testing, record all minor and major deviations, and submit the parking control equipment startup test records to the Program/Project manager for information:
 1. Lane Acceptance Test (LAT):
 - a. Test the Contractor's installed PRCS equipment at the lane level to ensure that the equipment meets the intent of the Contract as indicated in the operational sequences specified herein and revenue considerations.
 2. Operational Demonstration Test (ODT):
 - a. Test the fully installed Parking Revenue Control System (PRCS) to monitor the system during normal operating conditions to ensure the



system is functional over a defined period of time in a manner consistent with the intent of the Contract as indicated in the operational sequences specified herein and revenue considerations.

3.08 ADJUSTING

- A. Adjust noncompliant Parking Revenue Control System (PRCS) subsystems so the PRCS functions properly.

3.09 CLEANING

- A. Remove dirt and debris resulting from demolition and salvaging operations from the Site, and legally dispose of it.

3.10 PROTECTION

- A. Protect installed Parking Revenue Control System (PRCS) until it is placed into revenue service or until Final Completion, whichever comes first.

3.11 MAINTENANCE

- A. Emergency Services Maintenance:
 - 1. Operational Level Emergency Services Maintenance:
 - a. Ensure that the Owner's personnel have the operations and maintenance information to perform operational level emergency servicing of the parking control equipment.
 - 2. Technician Level Emergency Services Maintenance:
 - a. Provide technician level maintenance services to maintain the parking control equipment during emergency situations.
- B. Preventative Maintenance:
 - 1. Operational Level Preventative Maintenance:
 - a. Ensure that the Owner's personnel have the operations and maintenance information to perform operational level preventive maintenance of the parking control equipment.
 - 2. Technician Level Preventative Maintenance:
 - a. Provide technician level preventive maintenance services to maintain the parking control equipment.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 11152

EXPRESS EXIT STATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for express exit stations.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Existing express exit stations on the Site, and indicated to be relocated on the Contract Drawings, are to be removed, relocated, and reinstalled under this Contract at the locations shown on the Contract Drawings.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 11150 - Parking Control Equipment.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ISO: International Standards Organization.
 - 2. LAN: Local area network.
 - 3. LCIP: Lane control interface processor.
 - 4. LON: Local network.
 - 5. PC: Personal computer.
 - 6. PRCS: Parking revenue control system.
- B. Definitions:
 - 1. Emergency Services Maintenance: Those maintenance services that are performed in response to specific events, and are usually intended to return equipment or an application to an operational status following such an event.
 - 2. Express Exit Station or Express Exit Terminal or Exit Verifier: A PC-based PRCS device located in an express exit lane that facilitates multiple methods of exit from a parking facility, including ingesting and reading a magnetically encoded parking ticket, ingesting and reading a magnetically encoded access card or credit card, or reading a proximity access card or credit card fob via RFID.
 - a. The Exit Station uses the data from the inserted or detected media to validate exit privileges or calculate and process the associated parking fee.



- b. Fees can be paid via credit card, or exit is granted via access card or validated/pre-paid magnetically encoded ticket.
 - 3. Lane Control Interface Processor (LCIP): The processor used for communication between the parking revenue control system (PRCS) server and the lane equipment.
 - 4. Parking Revenue Control System (PRCS): A combination of equipment, software, subsystems, and supporting infrastructure that allows an entity to accurately calculate, collect, track, and report revenues for parking within one or more facilities.
 - a. A PRCS also monitors and controls ingress and egress to and from those facilities.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. International Electrotechnical Commission (IEC):
 - a. IEC 529 – Classification of Degrees of Protection by Enclosures.
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation of the Work of this Section with the contractor performing the work under East Economy Lot Toll Plaza Construction Package C05, and with the Program/Project Manager.
 - 2. Coordinate the installation and functions of the express exit stations with the Parking Revenue Control System (PRCS) requirements, including server requirements.
- B. Sequencing:
 - 1. Perform the Work of this Section in accordance with the Phasing sequence indicated on the Contract Drawings.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Express exit stations.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Express exit station manufacturer's installation instructions and recommendations.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance manuals for each express exit station provided under this Section.
 - 2) Documentation that maintenance and repair service for the express exit stations is available for emergency situations.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Comply with the requirements specified in the Phoenix Building Construction Code and Amendments.

B. Certifications:

1. Provide UL-listed express exit stations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver materials and equipment in a clean condition.
2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Handle materials and equipment in accordance with the manufacturer's written instructions.
2. Follow the manufacturer's written instructions for storing the items.
3. Store the express exit stations under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Existing Products:



1. Existing Owner-furnished express exit stations indicated in the Contract Documents to be removed, relocated, and reinstalled under this Contract are currently installed and functioning on the Site at the locations indicated on the Contract Drawings.

2.02 EQUIPMENT

A. Manufacturers:

1. Manufacturer List:
 - a. Scheidt & Bachmann, PL30/S Exit and Transit Controller, www.scheidt-bachmann.com.
 - b. Approved equal.
2. Substitution Limitations:
 - a. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
 - b. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with the Contract requirements.
3. Product Options:
 - a. Provide express exit stations including the following product options:
 - 1) Graphic color monitor with 5.7 inch, 1/4-VGA (320x240 Pixel).
 - 2) Audio output.
 - 3) Paint with P effect.
 - 4) Wiegand interface for third-party season parker card reader.
 - 5) Dry contacts, such as for roller gate control.
 - 6) Rain shielding as additional protection for the ticket tray.
 - 7) Cooling unit.
 - b. Product Data:
 - 1) Submit Product Data for the express exit stations proposed for the Work of this Section to the Program/Project Manager for approval, including a system description and an equipment list.

B. Regulatory Requirements:

1. Comply with the requirements specified in NFPA 70, the National Electrical Code.

C. Design Criteria:

1. Provide express exit stations designed for use outdoors as a ticket reader/validator, and having a PC-based lane control interface processor (LCIP) designed to control equipment component communications within the lane and to the parking revenue control system (PRCS) server.
 - a. In the event that network communication is lost, design the unit with the capability to perform the following stand-alone functions:
 - 1) Storing all transactional information for a minimum of 1,800 offline transactions.



- 2) Automatically shutting down in the event that the 1800 transaction threshold is reached and remaining closed until the reestablishment of online communications.
 - 3) Automatically uploading all stored transaction information to the parking revenue control system (PRCS) server once communication is restored.
 2. Magnetic Card Processing and Printer:
 - a. Provide a card terminal designed to accept and process parking tickets including ISO standard readable cards, magnetic stripe parking tickets, validations, and credit cards through a single slot that also has the capability to print a patron receipt and/or a credit card voucher that requires no signature.
 3. Cancel Button:
 - a. Provide a cancel button designed to allow a patron to cancel a transaction once a parking ticket has been inserted.
 4. Intercom:
 - a. Design the express exit station to have a ring-down, hands-free intercom integrated into the face of the unit.
 5. Operating Temperature:
 - a. Design the express exit stations to operate in the temperature range from minus 68 degrees Fahrenheit to 122 degrees Fahrenheit (minus 20 degrees Celsius to plus 50 degrees Celsius).
 6. Operating Humidity:
 - a. Design the express exit stations to operate in the range from 0 percent to 95 percent relative humidity.
 7. Power Supply:
 - a. Design the express exit stations to operate on a 120 Volt AC, 60 Hz single phase power supply.
- D. Materials:
 1. Housing:
 - a. Provide a stainless steel housing having a structure effect lacquer finish in a color selected by the Program/Project Manager.
 - b. International Protection:
 - 1) Provide an IPX3 rated enclosure complying with the requirements specified in IEC 529.
 2. Cooling Unit:
 - a. Provide an externally mounted cooling unit capable of protecting temperature sensitive internal components and maintaining optimal operating temperatures inside the express exit station housing.
 - b. Provide a cooling unit designed to be mounted on the housing.
 3. Computer and Control Unit:
 - a. For self-sufficient device control, provide an industrial personal computer (PC) having the following features:
 - 1) RS232 Serial Interfaces: 5.
 - 2) Inputs: 6 free binary inputs (including 2 x turnstile).



- 3) Outputs: 11 free binary outputs (including 2 x turnstile).
- b. Provide a computer capable of maintaining the basic functions of the device even in the case of network failure.
4. Display:
 - a. Provide an active color matrix display that is easily readable under all lighting conditions.
 - b. Provide an active color matrix display having a 6-inch minimum diagonal dimension.
 - c. Provide an alphanumeric display having 4 lines with 20 characters each.
5. Power Consumption:
 - a. Provide express exit stations consuming 60 VA to 120 VA for quiescent/working current and an additional 700 VA for heating/ventilation.
6. Connections:
 - a. Provide the following electrical/electronic connections for the express exit stations:
 - 1) Power supply.
 - 2) Network (LAN, LON).
 - 3) Intercom.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the area to receive each express exit station has been properly prepared to receive the equipment.
- B. Evaluation and Assessment:
 1. Do not install the express exit station equipment until the areas to receive the equipment are ready to receive the equipment.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Demolition / Removal:
 1. Remove and salvage existing express exit stations for relocation and reinstallation as indicated on the Contract Drawings.

3.03 INSTALLATION

- A. Install the express exit stations in accordance with the manufacturer's installation instructions and recommendations.



1. Submit the express exit station manufacturer's installation instructions and recommendations to the Program/Project Manager for information.
- B. Interface with Other Work:
 1. Connect the express exit stations to the electrical power supply.
- C. Systems Integration:
 1. Connect the express exit stations to the Parking Revenue Control System (PRCS) host server conductors.
 2. Connect the express exit stations to the Parking Revenue Control System (PRCS) intercom system.

3.04 RE-INSTALLATION

- A. Relocate and reinstall the Owner-furnished express exit stations on the Site at the locations shown on the Contract Drawings.

3.05 SYSTEM STARTUP

- A. Startup for express exit stations will be included in Parking Revenue Control System (PRCS) startup as specified in Section 11150, Parking Control Equipment.

3.06 PROTECTION

- A. Protect installed express exit stations until they are placed into revenue service or until Final Completion, whichever comes first.

3.07 MAINTENANCE

- A. Operation and Maintenance Manuals:
 1. Prepare operation and maintenance manuals for the express exit stations, including wiring diagrams.
 - a. Submit 2 copies of the operation and maintenance manuals for each product provided under this Section to the Program/Project Manager.
 - b. Submit 2 copies of the riser, layout, and special wiring diagrams to the Program/Project Manager showing any changes to the standard drawings.
- B. Maintenance and Repair Service:
 1. Verify that maintenance and repair service for the express exit stations is available for emergency situations.
 - a. Submit documentation that maintenance and repair service is available for emergency situations to the Program/Project Manager.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 11153

PROXIMITY CARD READERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for 125 kHz proximity card readers for indoor and outdoor parking and access control applications.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Existing Owner-furnished proximity card readers and their pedestals on the Site, and indicated to be relocated on the Contract Drawings, are to be removed, relocated, and reinstalled under this Contract at the locations shown on the Contract Drawings.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AVI: Automated vehicle identification.
 - 2. DIP: Dual In-line Package.
 - 3. PRCS: Parking revenue control system.
- B. Definitions:
 - 1. Automated Vehicle Identification (AVI): A technology whereby an RFID reader, focused on a specific drive lane, can detect and record passing vehicles that are equipped with an associated RFID transponder, such as a toll tag.
 - a. AVI technology can be integrated with other entry or exit lane equipment as a subsystem to the Parking Revenue Control System (PRCS).
 - 2. DIP Switches: A bank of miniature on-off switches mounted in computer hardware, such as on a circuit board or other device, and that holds configuration or setup information for that device. DIP switches are used to set the DMX address and mode of operation of electronic equipment.
 - 3. Keyfob: A plastic device, roughly the size of a car key, that works like a card having electronic circuitry that works with proximity card readers.
 - 4. Light Emitting Diode (LED): A type of light fixture commonly used for dynamic signage.



5. Radio Frequency Identification (RFID): The technology utilized by AVI systems and proximity card systems, for identifying a patron's credential.
 - a. An RFID system consists of an antenna, a transceiver which reads the radio frequency and transfers the information to a processing device, and a transponder, also called a tag which is an integrated circuit containing the RF circuitry and information to be transmitted.
6. Radio Frequency Interference/Electromagnetic Interference (RFI/EMI): Phenomena that occur when the radio frequency of the electromagnetic field of one device disrupts, degrades, or impedes another device.

C. Reference Standards:

1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
3. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.
 - b. UL 294 – Standard for Access Control System Units.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation and functions of the proximity card readers with the Phoenix Sky Harbor International Airport access requirements, including server requirements.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Proximity card readers.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Proximity card reader test results.
 - b. Manufacturer's Instructions:
 - 1) Proximity card reader manufacturer's installation instructions and recommendations.



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance manuals for each proximity card reader provided under this Section.
 - 2) Documentation that maintenance and repair service for the proximity card readers is available for emergency situations.
 - b. Warranty Documentation:
 - 1) Proximity card reader manufacturer's standard lifetime warranty.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Comply with the requirements specified in the Phoenix Building Construction Code and Amendments and NFPA 70.
2. Provide proximity card readers complying with the RFI/EMI certification requirements of the Federal Communications Commission (FCC).

B. Certifications:

1. Provide proximity card readers complying with the requirements specified in UL 294, and UL-listed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver materials and equipment in a clean condition.
2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Handle materials and equipment in accordance with the manufacturer's written instructions.
2. Follow the manufacturer's written instructions for storing the items.
3. Store the proximity card readers under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Provide the proximity card reader manufacturer's standard lifetime warranty against defects in materials and workmanship.
2. Submit the proximity card reader manufacturer's standard lifetime warranty to the Program/Project Manager.



PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

- A. Existing Products:
 - 1. Existing Owner-furnished proximity card readers and their pedestals indicated in the Contract Documents to be removed, relocated, and reinstalled under this Contract are currently installed and functioning on the Site at the locations indicated on the Contract Drawings.

2.02 EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. HID Global, an ASSA ABLOY Group brand, MaxiProx 5375, www.hidglobal.com
 - b. Approved equal.
 - 2. Substitution Limitations:
 - a. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
 - b. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with the Contract requirements.
 - 3. Product Options:
 - a. Product Data:
 - 1) Submit Product Data for the proximity card readers proposed for the Work of this Section to the Program/Project Manager for approval, including a system description and an equipment list.
- B. Performance:
 - 1. Provide proximity card readers capable of read range distances of up to 20 inches, and allowing read ranges to be maintained within 4 inches of metal.
 - 2. Baud Rates:
 - a. Provide proximity card readers having serial interfaces capable of supporting baud rates of 1200, 2400, 4800, and 9600 baud.
 - 3. Provide proximity card readers capable of recognizing card formats up to 85 bits.
- C. Design Criteria:
 - 1. Provide self-contained proximity card readers designed read properly configured cards manufactured by HID Global, designed to connect to a loop detector to ensure accurate detection of vehicles in vehicle lanes, and designed to have internal or host control of a multicolor LED and beeper.



- a. Provide internal DIP switches and jumpers capable of configuring the outputs, audible tone, and LED control options.
 2. Outputs:
 - a. Provide configurable open collector data outputs for providing data to the host server and/or parking control equipment.
 3. Transmit Frequency:
 - a. Provide proximity card readers designed to transmit at a frequency of 125 kilohertz.
 4. Operating Temperature:
 - a. Provide proximity card readers designed to operate in the temperature range from minus 22 degrees Fahrenheit to 150 degrees Fahrenheit.
 5. Operating Humidity:
 - a. Provide proximity card readers designed to operate in the range from 0 percent to 95 percent relative humidity.
 6. Access Protocol Systems:
 - a. Provide proximity card readers capable of interfacing with the following existing access protocol systems selectable in the field via configurable DIP switches and jumpers:
 - 1) Wiegand.
 - 2) Clock-and Data.
 - 3) RS-232.
 - 4) RS-422.
 - 5) RS-485.
 7. Security:
 - a. Provide proximity card readers having a tamper switch designed to provide electronic notification of reader tampering to the host server when the enclosure is opened.
- D. Operation:
 1. Operation Sequences:
 - a. When the proximity card reader is powered up, an internal self-test routine is initiated to check and verify the setup configuration, to determine the interior or external control of the LED and beeper, and to initialize the reader's operation.
 - b. When a proximity card (transponder) is presented to the proximity card reader, the red LED flashes green for approximately 250 milliseconds (unless under host control), a beeper sounds, and appropriate electronic outputs are generated as indicated in Section 11150, Parking Control Equipment.
 - c. After the LED returns to red, the proximity card reader is reset and ready to read another proximity card (transponder).
- E. Materials:
 1. Enclosure:



- a. Provide a rugged, vandal-resistant, weatherproof two-piece polycarbonate proximity card reader enclosure designed to withstand harsh environments.
 - 1) Provide O-ring gasket to weather seal the enclosure together, and a cable fitting to seal the cable entry.
 - 2) Provide an enclosure mountable on a single gang electrical box.
 - b. Provide a pedestal for supporting the enclosure.
2. Pedestal:
 - a. Provide a mounting pedestal designed for mounting the enclosure.
3. Power Supply:
 - a. Provide a linear regulated power supply configurable to either 12 or 24 Volts DC, and rated at 2.0 Amperes.
 - 1) Do not provide switching type supplies.
 - b. Current Requirements:
 - 1) 12-Volt DC Supply:
 - a) Average Current: 200 milliamperes.
 - b) Peak Current: 700 milliamperes.
 - 2) 24-Volt DC Supply:
 - a) Average Current: 260 milliamperes.
 - b) Peak Current: 1.2 Amperes.
4. User Feedback:
 - a. Provide a bi-color LED and audible tone beeper.
 - b. The beeper may either be controlled internally or by the host server.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the area to receive each proximity card reader has been properly prepared to receive the equipment.
- B. Evaluation and Assessment:
 1. Do not install the proximity card reader equipment until the areas to receive the equipment are ready to receive the equipment.
 2. Avoid mounting areas having radio frequency interference/electromagnetic interference (RFI/EMI) whenever possible.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Demolition/Removal:



1. Remove and salvage existing proximity card readers for relocation and reinstallation as indicated on the Contract Drawings.

3.03 INSTALLATION

- A. Install the proximity card readers in accordance with the manufacturer's installation instructions and recommendations.
 1. Mount the proximity card readers at least 4 inches away from metallic surfaces 12 inches by 12 inches and larger using non-metal spacers if required.
 2. Do not provide metallic fasteners larger than a number 6 screw.
 3. Submit the proximity card reader manufacturer's installation instructions and recommendations to the Program/Project Manager for information.
- B. Provide an electrical box and mounting pedestal to mount the proximity card reader adjacent to the other lane equipment as shown on the Contract Drawings.
- C. Interface with Other Work:
 1. Connect the proximity card reader power input to an external DC power supply.
 - a. If 5-conductor cable is provided, the power supply and host server must have a common ground.
- D. Systems Integration:
 1. Connect the proximity card readers to the Phoenix Sky Harbor International Airport access host server conductors.
 - a. For Wiegand interface cable, the maximum length is 500 feet.
 - b. For RS232 interface cable, the maximum length is 50 feet.
 - c. For RS422 interface cable, the maximum length is 4000 feet.

3.04 RE-INSTALLATION

- A. Relocate and reinstall the Owner-furnished proximity card reader on the Site at the locations shown on the Contract Drawings.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Reader Tests:
 - a. Test Procedure:
 - 1) Perform the testing recommended by the manufacturer in the manufacturer's installation guide.
 - 2) Record and submit proximity card reader test results to the Program/Project Manager for information.
 - b. Acceptance Criteria:



- 1) Installed proximity card readers complying with the acceptance requirements of the manufacturer are acceptable.

B. Non-Conforming Work

1. Proximity card reader components and accessories that are not properly connected, and in working order, are unacceptable.

3.06 ADJUSTING

- A. Once each proximity card reader is mounted, tune the reader for best performance.

1. The two antennas furnished with the proximity card readers, one to generate the excite field and the other to receive card transmission data, must be “nulled” to keep them from interfering with each other.

3.07 PROTECTION

- A. Protect installed proximity card readers until they are placed into revenue service or until Final Completion, whichever comes first.

3.08 MAINTENANCE

- A. Operation and Maintenance Manuals:

1. Prepare operation and maintenance manuals for the proximity card readers, including wiring diagrams.
 - a. Submit 2 copies of the operation and maintenance manuals for each product provided under this Section to the Program/Project Manager.
 - b. Submit 2 copies of the riser, layout, and special wiring diagrams to the Program/Project Manager showing any changes to the standard drawings.

- B. Maintenance and Repair Service:

1. Verify that maintenance and repair service for the proximity card readers is available for emergency services maintenance during emergency situations.
 - a. Submit documentation that maintenance and repair service is available for emergency situations to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 11154

EMBEDDED PREFORMED LOOP SENSORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing embedded preformed loop sensors for the access control equipment at the locations indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Loop detectors.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's loop detector preparation instructions and recommendations.
 - 2) Manufacturer's loop detector installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 - 1. Store and handle the preformed loop sensors in accordance with the manufacturer's loop detector storage and handling requirements and recommendations.
 - a. Submit manufacturer's loop detector storage and handling requirements and recommendations to the Program/Project Manager for information.



PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Never-Fail Loop Systems, Inc., Model C, www.neverfail.com.
 - b. Approved equal.
- B. Substitution Limitations:
 - 1. The products specified establish standards for kind, quality, and function desired for this Contract.
 - 2. The use of a manufacturer's proprietary product name to designate materials is not intended to imply that the products named are required to be used to the exclusion of equivalent products of other manufacturers.
 - 3. Submit the manufacturer's material data and certificates of performance for proposed substitutions.
- C. Product Options:
 - 1. Submit the manufacturer's Product Data for each type of product indicated and provided.
- D. Performance:
 - 1. Provide inductive loop sensors installed in embedded conduits, and capable of detecting vehicular presence.
 - 2. Lead-In Flex Hose Strength:
 - a. Provide lead-in flex hoses capable of withstanding 250 psi without failure.
- E. Design Criteria:
 - 1. Provide preformed loop detectors compatible with the access control systems for which they will be integrated.
 - 2. Provide preformed loop detectors designed for installation in concrete, concrete overlay, or bridge decks.
- F. Materials:
 - 1. Loop Detectors:
 - a. Provide preformed, un-spliced loop detectors consisting of copper loop wires sealed in rubber asphalt filled polypropylene conduit.
 - 1) Loop Size:
 - a) Provide rectangular loops 6 feet long by 2 feet 6 inches wide.
 - 2) Conduit Nominal Sizes:
 - a) Provide 3/8-inch and 5/8-inch conduit.
 - 3) Wire:
 - a) Provide 16-gauge TFFN or THHN stranded single conductor wire with PVC insulation and a nylon exterior jacket.



- b) Provide loops having one continuous wire through the loop head, 5 wire turns, and the lead-in to prevent malfunctions due to splicing.
 - b. Lead-Ins:
 - 1) Encase the lead-in wire in a non-conductive flex hose consisting of seamless extruded polyester fiber braid reinforcement and a non-conductive, seamless extruded urethane non-perforated jacket.
 - 2) Completely fill the lead-in hose with hot rubberized asphalt.
 - 3) Twist the lead-in wire in the flex hoses minimum of 3 turns per foot for the entire length of the lead-in.
 - c. Expansion/Contraction Joints:
 - 1) To allow for movement of the pavement and to prevent breakage of the wire and/or conduit due to this movement, provide expansion/contraction joints at intervals along the loop.
 - 2) Expansion/Contraction Joint Length: 9 inches.
 - d. Lead-In/Loop Head Connections:
 - 1) Attach lead-ins to the loop heads using a schedule 80 CPVC tee.
- G. Fabrication:
 - 1. Factory Assembly:
 - a. Fill the conduit encasing the wire with hot rubberized asphalt which allows the wire loop to remain flexible once the asphalt cools, prevents incursion of moisture, and sets the turns of wire firmly in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Unfold the preformed loop sensor, and verify the loop and lead-in dimensions.
- B. Pre-Installation Testing:
 - 1. Test the preformed loop sensor prior to installation to verify that it has not been damaged.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Demolition / Removal:
 - 1. If installing loops in existing concrete/asphalt subbase, provide channels or grooves in the subbase properly sized to receive the loops.



3.03 INSTALLATION

- A. Install the embedded preformed loop sensors in accordance with the manufacturer's instructions and recommendations.
 - 1. Submit manufacturer's instructions and recommendations to the Program/Project Manager for information, including at a minimum the following:
 - a. Manufacturer's loop detector preparation instructions and recommendations.
 - b. Manufacturer's loop detector installation instructions.
- B. Lay out the loop on the surface or rebar in the future slab.
- C. Slide sleeves over the expansion/contraction joints, and secure the sleeves to the loop using electrical tape to prevent premature movement of the sleeves during the subsequent concrete pour.
- D. Install the loops prior to laying pavement.
 - 1. Secure the loops directly on top of the reinforcing steel using ty raps.
 - 2. Secure the lead-in underneath the reinforcing steel using ty raps.
- E. Systems Integration:
 - 1. Connect the lead-in to the appropriate system as indicated in the Contract Documents.

3.04 PROTECTION

- A. Avoid contact between the loops and installation equipment.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 11155

PARKING BARRIER GATES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for parking barrier gates and controllers.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Existing parking barrier gate equipment on the Site, and indicated to be relocated on the Contract Drawings, is to be removed, relocated, and reinstalled under this Contract at the locations shown on the Contract Drawings.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 16075 - Electrical Identification.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. A/D: Analog-to-digital.
 - 2. PRCS: Parking revenue control system.
 - 3. SPC: Statistical process control.
- B. Definitions:
 - 1. Emergency Services Maintenance: Those maintenance services that are performed in response to specific events, and are usually intended to return equipment or an application to an operational status following such an event.
- C. Reference Standards:
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:



1. Coordinate installation of the Work of this Section with the contractor performing the work under East Economy Lot Toll Plaza Construction Package C05, and with the Program/Project Manager.

B. Sequencing:

1. Perform the Work of this Section in accordance with the Phasing sequence indicated on the Contract Drawings.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Parking barrier gate equipment.
 - b. Shop Drawings:
 - 1) Parking barrier gate equipment.
 - c. Qualification Statements:
 - 1) Parking gate installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's parking barrier gate equipment preparation instructions and recommendations.
 - 2) Manufacturer's parking barrier gate equipment storage and handling requirements and recommendations.
 - 3) Manufacturer's parking barrier gate equipment installation methods.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance manuals for each parking barrier gate provided under this Section.
 - 2) Documentation that maintenance and repair service for the parking barrier gates is available for emergency situations.
 - b. Warranty Documentation:



- 1) Parking Barrier Gate Equipment Warranty.
- c. Record Documentation:
 - 1) Automatic gate fire permit.
 - 2) Automatic gate electrical permit.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. City of Phoenix Fire Department Requirements:
 - a. Obtain a fire permit from the City of Phoenix Fire Department, pay the permit fees, and submit copies of the permit to the Program/Project Manager for information.
 - 2. City of Phoenix Development Services Department Requirements:
 - a. Obtain a separate electrical permit from the City of Phoenix Development Services Department for each automatic vehicle parking barrier gate, pay the permit fees, and submit copies of the permit to the Program/Project Manager for information.
- B. Qualifications:
 - 1. Parking Gate Installer Qualifications:
 - a. Employ a factory-authorized parking gate installer trained to install gates and operation systems of the type specified under this Contract.
 - b. Submit the parking gate installer's qualifications, including a qualification statement from manufacturer, to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Provide products that are listed and labeled by Underwriters Laboratory, for the location installed in, and listed and labeled or approved for the application intended as indicated or specified, unless products meeting the requirements of this testing laboratory are not readily available, or unless standards do not exist for the products.
 - a. Provide products that are approved, listed, and labeled for the short circuit currents, voltages, and currents indicated or specified to be applied.
 - 2. Submit evidence of testing agency/quality verification, listing, and labeling for each product with the submitted Product Data, either by providing a printed mark on the data or by attaching a separate listing card.
 - a. For items without such evidence, submit a written statement from the product manufacturer that indicates why it does not have quality assurance verification.



1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store and handle parking barrier gate equipment in accordance with the manufacturer's requirements and recommendations.
 - a. Submit the parking barrier gate equipment manufacturer's storage and handling requirements and recommendations for each product provided to the Program/Project Manager for information.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Warrant the parking barrier gate equipment materials or workmanship in accordance with the manufacturer's standard warranty.
 - a. Submit a written Parking Barrier Gate Equipment Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured parking barrier gate equipment that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - b. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Existing Products:

1. Existing Owner-furnished parking barrier gate equipment indicated in the Contract Documents to be removed, relocated, and reinstalled under this Contract is currently installed and functioning on the Site at the locations indicated on the Contract Drawings.

2.02 EQUIPMENT

A. Manufacturers:

1. Manufacturer List:
 - a. Scheidt & Bachmann, www.scheidt-bachmann.com.
 - b. Approved equal.
2. Substitution Limitations:
 - a. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.



- b. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with the Contract requirements.
- 3. Product Options:
 - a. Provide parking barrier gate equipment having the following product options:
 - 1) "Barrier Open" function in case of power failure.
 - 2) Auto-reverse function upon detection of an obstruction.
 - 3) Statistical process control (SPC) module for special functions.
 - 4) Key-operated switch.
 - 1) Non-resettable gate movement counter.
 - b. Product Data:
 - 1) Submit Product Data for the parking barrier gate equipment proposed for the Work of this Section to the Program/Project Manager for approval, including a system description and an equipment list.

B. Description:

- 1. Regulatory Requirements:
 - a. Comply with the requirements of the City of Phoenix Fire Department regarding automatic vehicle access gates.

C. Performance:

- 1. Opening and Closing Criteria:
 - a. Provide parking barrier arms that open or clear in approximately 2 seconds.
 - b. Provide parking barrier gates complying with the following minimum opening and closing criteria:
 - 1) Open from 0 degrees to 80 degrees in approximately 1.2 seconds.
 - 2) Open from 0 degrees to 90 degrees in approximately 2.3 seconds.
 - 3) Close from 90 degrees to 25 degrees in approximately 1.2 seconds.
 - 4) Close from 90 degrees to 0 degrees in approximately 2.4 seconds.
- 2. Operating Temperature Range:
 - a. Provide parking barrier gates capable of operating within a temperature range from minus 4 degrees Fahrenheit (minus 20 degrees Celsius) to plus 122 degrees Fahrenheit (plus 50 degrees Celsius).



3. Operating Humidity Range:
 - a. Provide parking barrier gates capable of operating within a humidity range from plus or minus 0 percent to 95 percent.

D. Design Criteria:

1. Provide parking barrier gate equipment designed for exterior applications, and that are capable of accepting vehicle detection signals from loop detectors and other detection equipment that activate the gate's barrier beam.
2. Provide parking barrier gate equipment designed to be powered from an individual 20 Ampere minimum branch-circuit run to each gate.
 - a. Provide a minimum 3/4-inch raceway for the branch-circuit wiring.
3. Design the parking barrier gate to have a micro-switch that provides recognition of broken barrier beam shafts.
4. Shop Drawings:
 - a. Prepare Shop Drawings, including wiring diagrams, showing installation of the parking barrier gate equipment, and submit the Shop Drawings to the Program/Project Manager for approval.

E. Operation:

1. Operators:
 - a. Provide a barrier gate operator for each unit provided and capable of raising and lowering the swing-up barrier beam associated with the unit as specified herein.
 - 1) Provide an Analog/Digital (A/D) converter capable of facilitating degree-exact positioning of the barrier beam.
 - b. Motor:
 - 1) Provide a 1330 rpm, three-phase motor with integrated internal overload protection.
 - c. Power Supply:
 - 1) Provide equipment capable of operating on a 120 Volt, 60 Hertz power supply.
2. Controls:
 - a. Control and Acknowledge Signals:
 - 1) Provide controls capable of generating the following control and acknowledge signals:
 - a) Control Signals (Inputs):
 - (1) Open barrier.
 - (2) Closed barrier.
 - b) Acknowledge Signals (Outputs):
 - (1) Barrier beam broken.
 - (2) Barrier beam in final position "open".



- (3) Barrier beam in final position “closed”.
- b. Knox Key Switch:
 - 1) For each automatic gate, provide a City of Phoenix approved Knox key switch capable of allowing the Fire Department 24-hour access to the Site, and located 5-1/2 feet above grade on both entrance and exit sides of the gate.
- c. Emergency Gate Switch and Battery Backup:
 - 1) Install an emergency gate switch on both entrance and exit gates.
 - 2) The emergency gate switch must bypass all free access loop systems.
- 3. Operation Sequences:
 - 1) Under normal operating conditions the gate remains closed until either an “open barrier” signal activates the gate or the emergency gate switch is activated.
 - 2) Once the Knox key switch has activated the parking barrier gate, the gate must open and remain in the open position until deactivated by the Fire Department.
 - a) Only when the Knox key switch has been deactivated can the gate resume normal operation.

F. Materials:

- 1. Barrier Beam:
 - a. Provide a straight barrier beam having the following features:
 - 1) Profile: Octagonal.
 - 2) Length: 9.83 feet (3.00m).
 - 3) Color Scheme: Red/white.
- 2. Cabinet Housing:
 - a. Provide a stainless steel cabinet with a baked-on powder coat finish having a color selected by the Owner.
- 3. Fire Department Sign:
 - a. Provide a 0.080 thick aluminum sign, 8 inches wide and 4 inches high with rounded corners, and having a white reflective sheeting sign face.
 - 1) Apply DG3 4090 series or equivalent diamond grade reflective sheeting as manufactured by 3M Corporation to the aluminum plate as a background.
 - b. Provide an inverse legend that allows the reflective sheeting underneath to show through, and reading “FD ACCESS”.
 - 1) Apply inverse legends that are either cut from red 1172 series 3M Scotchlite acrylic, transparent, electronic cuttable film, or screen-printed using traffic sign red 3M Corporation 8801 or 880-00 series translucent ink.



PART 3 EXECUTION

3.01 OWNER-FURNISHED PRODUCTS

- A. Existing Products:
 - 1. Existing Owner-furnished parking barrier gates indicated in the Contract Documents to be removed, relocated, and reinstalled under this Contract are currently installed and functioning on the Site at the locations indicated on the Contract Drawings.

3.02 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the concrete pad(s) to receive the parking barrier gate equipment to verify they are ready to receive the equipment.
- B. Evaluation and Assessment:
 - 1. Do not install the parking barrier gate equipment until the areas to receive the equipment are ready to receive the equipment.
 - 2. Examine existing parking barrier gate equipment to be relocated and reinstalled as indicated on the Contract Drawings to verify that it is in a condition acceptable for reinstallation.

3.03 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Surface Preparation:
 - 1. Prior to installing parking barrier gate equipment, thoroughly clean the surfaces of the concrete pad(s) to receive the equipment.
 - 2. Prepare the surfaces using the methods recommended by the manufacturer.
 - a. Submit the parking barrier gate equipment manufacturer's preparation instructions and recommendations for each product provided to the Program/Project Manager for information.
 - 3. Do not begin installation of the parking barrier gate equipment until the substrates have been properly prepared.



C. Demolition/Removal:

1. Remove and salvage existing parking barrier gate equipment for relocation and reinstallation as indicated on the Contract Drawings.

3.04 INSTALLATION

1. Install the parking barrier gate equipment in accordance with manufacturer's instructions.
 - a. Submit the manufacturer's installation methods for each product provided to the Program/Project Manager for information.
2. Mount the parking barrier gate equipment directly to the concrete pad(s), plumb, level, and firmly secured.
3. Wire the parking barrier gate equipment in accordance with the requirements specified in NFPA 70, the National Electric Code.
 - a. Enclose splices in easily accessible junction boxes, or provide terminal boards.
 - b. Tag and identify the cable runs in the junction boxes in accordance with the requirements specified in Section 16075, Electrical Identification.

B. Interface with Other Work:

1. Make the electrical and control connections required to provide complete and operational parking barrier gate systems.

3.05 REPAIR/RESTORATION

- A. Touch-up or repair parking barrier gate equipment damaged before Final Completion, or replace the damaged equipment with new undamaged equipment.

3.06 RE-INSTALLATION

- A. Relocate and reinstall the Owner-furnished parking barrier gate equipment on the Site at the locations shown on the Contract Drawings.

3.07 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:
 - a. Parking Barrier Gate Systems Test:
 - 1) Test Procedure:



- a) Test the parking barrier gate systems to assure the components and accessories are properly connected and in working order.
 - 2) Acceptance Criteria:
 - a) Properly functioning parking barrier gate equipment is acceptable.
- 2. Inspections:
 - a. City of Phoenix Development Services Department Inspection:
 - 1) Prior to the final inspection for the parking barrier gates by the City of Phoenix Fire Department, have the Development Services Department inspect the depths of the conduit for gate operators and the Knox key switches in order to obtain a “rough electrical green tag” that reads “Underground Electric for Gates”.
 - 2) After gate installation and modifications are completed, have the Development Services Department perform a final electrical inspection of the gate operators in order to obtain an electrical green tag that reads “Final Electrical for Gates”.
 - b. *City of Phoenix Fire Department Inspection:*
 - 1) *Prior to the final gate inspection by the City of Phoenix Fire Department, obtain the electrical green tag for the gate operators.*
 - 2) *Ensure that stamped plans approved by the City of Phoenix Fire Department and the required permits are onsite at the time of the final gate field inspection by the City of Phoenix Fire Department.*
 - 3) *After gate installation and modifications are completed, have the Fire Department perform a final inspection of the gates.*
- B. Non-Conforming Work:
 - 1. Parking barrier gate components and accessories that are not properly connected, and in working order, are unacceptable.

3.08 ADJUSTING

- A. Make adjustments to non-conforming Work to assure the components and accessories are properly connected and in working order.

3.09 PROTECTION

- A. Protect installed parking barrier gate equipment until it is placed into revenue service or until Final Completion, whichever comes first.

3.10 MAINTENANCE

- A. Operation and Maintenance Manuals:



1. Prepare operation and maintenance manuals for the parking barrier gate equipment, including wiring diagrams.
 - a. Submit 2 copies of the operation and maintenance manuals for each product provided under this Section to the Program/Project Manager.
 - b. Submit 2 copies of the riser, layout, and special wiring diagrams to the Program/Project Manager showing any changes to the standard drawings.
- B. Maintenance and Repair Service:
 1. Verify that maintenance and repair service for the parking barrier gate equipment is available for emergency services maintenance during emergency situations.
 - a. Submit documentation that maintenance and repair service is available for emergency situations to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 11157

LICENSE PLATE RECOGNITION CAMERAS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for infrared license plate recognition cameras and software.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01555 - Traffic Control.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 11150 - Parking Control Equipment.
 - 5. Section 11154 - Embedded Preformed Loop Sensors.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ALPR: Automatic license plate recognition.
 - 2. ANPR: Automatic number plate recognition.
 - 3. AVI: Automated vehicle identification.
 - 4. CCD: Charged coupled device.
 - 5. CPR: Car plate recognition.
 - 6. TVL: Television lines.
 - 7. IR: Infrared wavelength.
 - 8. LED: Light emitting diode.
 - 9. LPI: License plate inventory.
 - 10. LPN: License plate number.
 - 11. LPR: License plate recognition.
 - 12. PRCS: Parking revenue control system.
 - 13. RFID: Radio frequency identification.
- B. Definitions:
 - 1. Automated Vehicle Identification (AVI): A technology whereby an RFID reader, focused on a specific drive lane, can detect and record passing vehicles that are equipped with an associated RFID transponder, such as a toll tag.
 - a. The term automated vehicle identification (AVI) is also sometimes used interchangeably with the term automatic number plate recognition (ANPR) to indicate a surveillance method to read the license plates on vehicles, but has the definition above under this Contract.



2. Automatic Number Plate Recognition (ANPR): A mass surveillance method that uses optical character recognition on images to read the license plates on vehicles.
 - a. ANPR is also referred to by other terminology including automatic license plate recognition (ALPR), automated vehicle identification (AVI), car plate recognition (CPR), and license plate recognition (LPR).
3. Charged Coupled Device (CCD): A light-sensitive image device used in many digital cameras consisting of a large integrated circuit that contains hundreds of thousands of photo-sites (pixels) that convert light energy into electronic signals.
 - a. Its size is measured diagonally, and can be 1/4 inch, 1/3 inch, 1/2 inch, or 2/3 inch.
4. Emergency Services Maintenance: Those maintenance services that are performed in response to specific events, and are usually intended to return equipment or an application to an operational status following such an event.
5. License Plate Inventory (LPI): A combination of manual or automated processes that result in the accurate collection of the license plate numbers of all vehicles parked within a facility at the time the inventory is performed; a subsystem to a PRCS.
6. Parking Revenue Control System (PRCS): A combination of equipment, software, subsystems, and supporting infrastructure that allows an entity to accurately calculate, collect, track, and report revenues for parking within one or more facilities.
 - a. A PRCS also monitors and controls ingress and egress to and from those facilities.
7. Pixel: Short for picture element, a single point in a graphic image.
 - a. Graphics monitors display pictures by dividing the display screen into a large number of pixels arranged in rows and columns that are so close together that the pixels appear to be connected to form a continuous image.
8. Television Lines (TVL): A measure of image resolution, usually given in horizontal lines, and approximated by multiplying the number of pixels by 0.7.

C. Reference Standards:

1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:



1. Coordinate the installation and functions of the each license plate recognition cameras with the Parking Revenue Control System (PRCS) requirements, including server requirements.

B. Sequencing:

1. Perform the Work of this Section in accordance with the Phasing sequence indicated on the Contract Drawings.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) License plate recognition cameras and accessories.
 - b. Shop Drawings:
 - 1) License plate recognition cameras and accessories.
 - c. Qualification Statements:
 - 1) License plate recognition camera installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) License plate recognition camera test results.
 - b. Manufacturer's Instructions:
 - 1) License plate recognition camera manufacturer's installation instructions and recommendations.
 - 2) License plate recognition camera manufacturer's preparation instructions and recommendations.
 - 3) License plate recognition camera manufacturer's storage and handling requirements and recommendations.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance manuals for each license plate recognition camera product provided under this Section.
 - 2) Documentation that maintenance and repair service for the license plate recognition cameras is available for emergency situations.
 - b. Warranty Documentation:



- 1) License plate recognition camera manufacturer's standard warranty.
- c. Software:
 - 1) Backup copies of the license plate recognition software.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Comply with the requirements specified in the Phoenix Building Construction Code and Amendments and NFPA 70.
- B. Qualifications:
 1. License Plate Recognition Camera Installer Qualifications:
 - a. Employ a factory-authorized license plate recognition camera installer trained to install license plate recognition camera systems of the type specified under this Contract.
 - b. Submit the license plate recognition camera installer's qualifications, including a qualification statement from manufacturer, to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials and equipment in a clean condition.
 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Store and handle license plate recognition camera equipment in accordance with the manufacturer's requirements and recommendations.
 - a. Submit the license plate recognition camera manufacturer's requirements and recommendations to the Program/Project Manager for information.
 2. Store the license plate recognition cameras and accessories under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

1.07 WARRANTY

- A. Manufacturer Warranty:
 1. Provide the license plate recognition camera manufacturer's standard warranty against defects in materials and workmanship.
 2. Submit the license plate recognition camera manufacturer's standard warranty to the Program/Project Manager.



PART 2 PRODUCTS

2.01 INFRARED LICENSE PLATE RECOGNITION CAMERAS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Derwent Systems, Ltd., REG-L1,
<https://www.securityinformed.com/derwent-reg-technical-details.html>.
 - b. Approved equal.
 - 2. Substitution Limitations:
 - a. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
 - b. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with the Contract requirements.
 - 3. Product Options:
 - a. Provide license plate recognition cameras having the following product options:
 - 1) Lens.
 - a) For a 3m to 6m range, provide a 12mm lens.
 - b) For a 5m to 8m range, provide a 16mm lens.
 - 2) Mounting Bracket:
 - a) Provide a yellow pole top mount bracket, or a yellow side pole mount bracket.
 - 3) Power Supply Unit:
 - a) Provide a power supply unit capable of supplying power as specified herein from power mains.
 - b) Manufacturers:
 - (1) Derwent Systems, Ltd., Model PSU230-24-75W,
<https://www.securityinformed.com/derwent-reg-technical-details.html>.
 - (2) Approved equal.
 - b. Product Data:
 - 1) Submit Product Data for the parking barrier gate equipment proposed for the Work of this Section to the Program/Project Manager for approval, including a system description, an equipment list, and available housing colors to be selected by the Owner.
- B. Regulatory Requirements:
 - 1. Comply with the requirements specified in NFPA 70, the National Electrical Code.
- C. Performance:



1. Provide license plate recognition cameras having the following characteristics:
 - a. Resolution:
 - 1) Provide high resolution license plate recognition cameras having 600 television lines (TVL).
 - b. Operational (Capture) Range:
 - 1) Provide license plate recognition cameras having an operational (capture) range from 1.5m (5 feet) to 8m (26 feet).
 - 2) Provide license plate recognition cameras having the high speed optical synchronization to capture plate images from vehicles moving at speeds of up to 20 miles per hour (32kph).
 - c. Average Illuminator Life:
 - 1) Provide illuminators for the license plate recognition cameras having an average illuminator life greater than 5 years.
 - d. Temperature Range:
 - 1) Provide license plate recognition cameras capable of operating within the temperature range from plus 50 degrees Celsius (122 degrees Fahrenheit) to minus 50 degrees Celsius (minus 58 degrees Fahrenheit).

D. Design Criteria:

1. Provide license plate recognition cameras designed to generate high contrast images of retro-reflective license plates across the complete spectrum of ambient lighting conditions from total darkness to direct glare from sunlight and headlights; to work on a stand-alone basis with VCRs, DVDs, and specifically with third party automatic number plate recognition (ANPR) software; and to comply with the following additional design parameters:
 - a. Camera Sensor:
 - 1) Provide license plate recognition cameras having 1/2-inch LXR charged coupled device (CCD) sensors.
 - b. Infrared Wavelength (IR) Illumination:
 - 1) Provide license plate recognition cameras having a high resolution array of metaphase LEDs producing 850nm wavelength infrared illumination.
 - c. Electrical Power:
 - 1) Electrical Input:
 - a) Provide license plate recognition cameras capable of operating with an electrical input of 12 Volts - 24 Volts AC/DC.
 - 2) Power Consumption:
 - a) Provide license plate recognition cameras that have a power consumption of 30 Watts.
2. Shop Drawings:
 - a. Prepare Shop Drawings of the license plate recognition camera equipment, including mounting bracket diagrams and wiring diagrams,



showing installation of the equipment; and submit the Shop Drawings to the Program/Project Manager for approval.

E. Operation:

1. Operators:
 - a. Embedded loop detectors provided under Section 11154, Embedded Preformed Loop Sensors, activate the license plate recognition cameras via the parking revenue control system (PRCS).
2. Controls:
 - a. The parking revenue control system (PRCS) host servers control the processing and storage of images created by the license plate recognition cameras as indicated in Section 11150, Parking Control Equipment.
3. Operation Sequences:
 - a. When vehicles traveling in a license plate recognition camera's lane activate embedded loop detectors provided under Section 11154, Embedded Preformed Loop Sensors, appropriate signals are generated and are relayed to the license plate recognition cameras by the parking revenue control system (PRCS) as indicated in Section 11150, Parking Control Equipment.
 - b. The license plate recognition camera uses an integral infrared illuminator to illuminate the vehicle's license plate number (LPN) and takes an electronic infrared image of the LPN.
 - c. Parking revenue control system (PRCS) software uses image manipulation techniques to detect, normalize, and enhance the image of the number plate, applies optical character recognition (OCR) to extract the alphanumerics of the license plate, and stores it in the parking revenue control system (PRCS) license plate inventory (LPI) for future retrieval.

F. Materials:

1. Camera Housings:
 - a. Provide license plate recognition cameras that have weatherproof aluminum castings and extrusion housings.
 - b. Dimensions: 250mm by 154mm by 165mm.
 - c. Color: Owner selectable.
 - d. Weight: 2.8kg.
2. Camera Mounting Pedestal:
 - a. Provide camera mounting pedestals sized according to the camera manufacturer's recommendations for the locations indicated on the Contract Drawings.
3. License Plate Recognition Cameras:
 - a. Provide license plate recognition cameras having the design and performance characteristics specified herein.



2.02 ACCESSORIES

- A. License Plate Recognition Software:
 - 1. Provide license plate recognition software compatible with the parking revenue control system (PRCS) host servers, and capable of using image manipulation techniques to detect, normalize, and enhance the images of the number plates taken by the license plate recognition cameras, apply optical character recognition (OCR) to extract the alphanumerics of all types of Arizona license plates, and stores them in the parking revenue control system (PRCS) license plate inventory (LPI) for future retrieval.
 - a. Submit backup copies of the license plate recognition software to the Program/Project Manager.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the area to receive each license plate recognition camera has been properly prepared to receive the equipment.
- B. Evaluation and Assessment:
 - 1. Do not install the license plate recognition camera equipment until the areas to receive the equipment are ready to receive the equipment.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Maintain and protect traffic on active streets and roads in accordance with the requirements specified in Section 01555, Traffic Control.
- B. Surface Preparation:
 - 1. Prepare the surfaces to receive the license plate recognition cameras in accordance with the manufacturer's preparation instructions and recommendations.
 - a. Submit the license plate recognition camera manufacturer's preparation instructions and recommendations to the Program/Project Manager for information.
- C. Demolition / Removal:
 - 1. Demolish and remove existing license plate recognition cameras indicated to be removed on the Contract Drawings.

3.03 INSTALLATION

- A. Furnish and install the license plate recognition cameras and mounting pedestals at the locations indicated on the Contract Drawings and in



accordance with the manufacturer's installation instructions and recommendations.

1. Submit the license plate recognition camera manufacturer's installation instructions and recommendations to the Program/Project Manager for information.

B. Interface with Other Work:

1. Make the electrical and control connections required to provide complete and operational license plate recognition camera systems.

C. Systems Integration:

1. Integrate the license plate recognition camera equipment with other parking control equipment provided and/or installed under this Contract as specified in Section 11150, Parking Control Equipment.
 - a. Connect the license plate recognition cameras to the Parking Revenue Control System (PRCS) host server conductors.
 - b. Install compatible license plate recognition software on the parking revenue control system (PRCS) host servers as required to provide the license plate inventory (LPI) as defined herein.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. License Plate Recognition Cameras Tests:
 - a. Test Procedure:
 - 1) Perform the testing recommended by the equipment manufacturer in the manufacturer's installation guide, and diagnostic testing recommended by the software vendor.
 - 2) Record and submit license plate recognition camera test results to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Installed license plate recognition cameras complying with the acceptance requirements of the manufacturer and software vendor are acceptable.

B. Non-Conforming Work

1. License plate recognition camera components and accessories that are not properly connected, and in working order, are unacceptable.

3.05 SYSTEM STARTUP

- A. Startup for license plate recognition cameras will be included in Parking Revenue Control System (PRCS) startup as specified in Section 11150, Parking Control Equipment.



3.06 ADJUSTING

- A. Adjust the license plate recognition camera mounting and angles as required to capture the images of the license plates of the vehicles traveling in the camera's lane at the time when triggered by the embedded sensors.

3.07 PROTECTION

- A. Protect installed license plate recognition cameras until they are placed into revenue service or until Final Completion, whichever comes first.

3.08 MAINTENANCE

- A. Operation and Maintenance Manuals:
 - 1. Prepare operation and maintenance manuals for the license plate recognition cameras, including wiring diagrams.
 - a. Submit 2 copies of the operation and maintenance manuals for each product provided under this Section to the Program/Project Manager.
 - b. Submit 2 copies of the riser, layout, and special wiring diagrams to the Program/Project Manager showing any changes to the standard drawings.
- B. Maintenance and Repair Service:
 - 1. Verify that maintenance and repair service for the license plate recognition cameras is available for emergency services maintenance during emergency situations.
 - a. Submit documentation that maintenance and repair service is available for emergency situations to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 11735

AUTOMATED EXTERNAL DEFIBRILLATORS (AED)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for automated external defibrillators (AEDs).
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01770 - Closeout Procedures.
 - 5. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AED: Automated external defibrillator.
- B. Reference Standards:
 - 1. Association for the Advancement of Medical Instrumentation (AAMI):
 - a. ANSI/AAMI DF80 – Medical Electrical Equipment--Part 2-4: Particular Requirements for the Safety of Cardiac Defibrillators (Including Automated External Defibrillators).
 - 2. United States Government:
 - a. Department of Justice:
 - 1) 28 CFR 36 Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - b. Office of the Secretary of Transportation:
 - 1) 49 CFR 37 Transportation Services for Individuals with Disabilities (ADA).
 - c. Parks, Forests, and Public Property:
 - 1) 36 CFR 1192 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
 - d. United States Code (U.S.C.):
 - 1) 42 U.S.C. Section 4151 et seq.
 - a) Architectural Barriers Act, Public Law 90-480.
 - 2) 42 U.S.C. Section 12101 et seq.
 - a) Americans with Disabilities Act (ADA), Public Law 101-336.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the acquisition, delivery, and installation of the automated external defibrillator (AED) equipment with the Program/Project Manager.
 - a. Coordinate installation of the automated external defibrillator (AED) devices with the Program/Project Manager and Phoenix Sky Harbor International Airport's locksmith.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Automated external defibrillators (AEDs) cabinets.
 - 2) Automated external defibrillator (AED) custom pedestal mounts.
 - b. Shop Drawings:
 - 1) Automated external defibrillator (AED) custom pedestal mounts.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Automated external defibrillator (AED) component manufacturers' written instructions for handling and storing their products.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and Maintenance Manuals for the automated external defibrillators (AEDs).
 - b. Record Documentation:
 - 1) Record Drawing documents and as-built Shop Drawings for the automated external defibrillators (AEDs).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver automated external defibrillator (AED) components in a clean, undamaged condition.



2. Inspect automated external defibrillator (AED) components for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Handle automated external defibrillator (AED) components in accordance with their manufacturer's written instructions.
 2. Follow the manufacturer's written instructions for storing the automated external defibrillator (AED) components.
 3. Submit the automated external defibrillator (AED) component manufacturers' written instructions for handling and storing their products to the Project/Project Manager for information.
- C. Packaging Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 AUTOMATED EXTERNAL DEFIBRILLATORS (AED) EQUIPMENT

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:
 - a. Accessibility and ADA Requirements
 - 1) Provide automated external defibrillators (AEDs), cabinets, and custom AED pedestal mounts that at a minimum comply with the requirements specified in the American with Disabilities Act (ADA) Accessibility Guideline, and with the following criteria:
 - a) Provide automated external defibrillators (AEDs), cabinets, and custom AED pedestal mounts that are highly visible and easily identifiable to the traveling public, and wherever possible have 360 degree visibility.
 - b) Mount the bottom of the cabinets 27 inches from the finished floor level.
 - (1) Take measures to ensure that the cabinets are not obstructions.



C. Performance:

1. Automated External Defibrillators (AEDs):

- a. The automated external defibrillators (AEDs) will be battery-powered Heartstream FR2 semi-automatic automated external defibrillators (AEDs) manufactured by Agilent Technologies, Inc., will comply with the requirements specified in ANSI/AAMI DF80, and will be designed to operate within the following ranges:

- 1) Temperature Range:

- a) The automated external defibrillators (AEDs) are capable of functioning within the operating temperature range from 32 degrees Fahrenheit (0 degrees Celsius) to 122 degrees Fahrenheit (50 degrees Celsius).

- 2) Humidity Range:

- a) The automated external defibrillators (AEDs) are capable of functioning within the non-condensing relative humidity range from 0 percent to 95 percent.

D. Design Criteria:

1. Automated External Defibrillators (AEDs):

- a. At the locations indicated in the Contract Documents, provide automated external defibrillators (AEDs), cabinets, and custom pedestals.
 - 1) The automated external defibrillators (AEDs) must be purchased from the City of Phoenix Fire Department for installation under this Contract.
- b. Size:
 - 1) The automated external defibrillators (AEDs) are approximately 2.6 inches high by 8.6 inches wide by 8.6 inches deep.
- c. Weight:
 - 1) The automated external defibrillators (AEDs) weigh approximately 4.7 pounds with the battery installed.

2. Product Data:

- a. Obtain the manufacturers' Product Data for the automated external defibrillator (AED) cabinets and custom AED pedestal mounts.
- b. Submit the automated external defibrillator (AED) cabinet and custom AED pedestal mount manufacturers' Product Data to the Program/Project Manager for approval.

3. Shop Drawings:

- a. Prepare Shop Drawings for the automated external defibrillator (AED) custom pedestal mounts showing the fabrication, conduit knockouts, and installation of the pedestal mounts to be provided under this Section including mounting templates; and showing the location and type of mounting, wall or pedestal, for the automated external defibrillators (AEDs) based on the results of the Contractor's Site survey.



- b. Submit the automated external defibrillator (AED) custom pedestal mount Shop Drawings to the Program/Project Manager for approval.

E. Components:

- 1. Automated External Defibrillators (AEDs):
 - a. Purchase Agilent Technologies, Incorporated's Heartstream automated external defibrillators (AEDs) from the City of Phoenix Fire Department.
 - b. Manufacturer:
 - 1) Koninklijke Philips Electronics N.V., Phillips Healthcare, Heartstream, <http://www.healthcare.philips.com/main/index.wpd>.
 - a) In 2001 Heartstream became part of Philips Medical Systems, when Philips purchased Agilent Technologies, Incorporated's entire Medical Group.
 - b) In 2002, all Philips defibrillators were rebranded as HeartStart Defibrillators, and Philips introduced the HeartStart HS1 family of AEDs, including the Philips and Laerdal HeartStart, and Philips HeartStart Home, and Philips HeartStart OnSite defibrillators.
- 2. Automated External Defibrillator (AED) Cabinets:
 - a. Provide automated external defibrillator (AED) cabinets fabricated from welded 16 gauge steel, and having an impact resistant 3/16-inch thick acrylic window.
 - b. Provide fully alarmed automated external defibrillator (AED) cabinets having a security tie-in to the security system, a pressure switch, and a 12-Volt lithium battery pack to power alarms.
 - 1) Provide audible alarms that deliver a 120 decibel high output alarm for 30 seconds followed by an intermittent voice tone.
 - 2) Provide high intensity strobe lights.
 - c. Theft Deterrence:
 - 1) Provide automated external defibrillator (AED) cabinets having a theft deterrence system.
 - d. Monitoring:
 - 1) Provide automated external defibrillator (AED) cabinets having continual self-monitoring circuitry powered by a 9-Volt battery.
 - e. Hardware:
 - 1) Provide automated external defibrillator (AED) cabinets having flush, industrial strength hardware.
 - 2) Provide security tie-in and lock shall be H2523.
 - 3) The Phoenix Sky Harbor International Airport's locksmith will provide keying in accordance with the Airport's keying system.
 - f. Finish:
 - 1) Provide powder coated automated external defibrillator (AED) cabinets having protection from damage caused by ultraviolet light.
 - a) Cabinet shall be stainless steel.



- g. Manufacturers:
 - 1) HeartStation, Basis-of Design: Model RC5000RSPB, <http://www.heartstation.com>.
 - 2) Approved equal.
- 3. Automated External Defibrillator (AED) Custom Pedestal Mounts:
 - a. Provide sturdy automated external defibrillator (AED) custom pedestal mounts fabricated as detailed on the Contract Drawings from welded 16 gauge steel.
 - a. Finish:
 - 1) Provide finishes for the automated external defibrillator (AED) custom pedestal mounts matching the finishes on the automated external defibrillator (AED) cabinets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. After receiving the Notice to Proceed, conduct a Site survey of the automated external defibrillator (AED) locations defined in the Contract Documents to validate the placement of the automated external defibrillator (AED) devices and directional signage in accordance with requirements specified.
 - a. Based on the results of this Site survey, recommend the automated external defibrillator's (AED's) final locations, and update the Record Documentation specified in Paragraph 3.06.B accordingly.
- B. Evaluation and Assessment:
 - 1. Proceed installing the automated external defibrillators (AEDs) only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the automated external defibrillators (AEDs).
- B. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Automated External Defibrillator (AED) Cabinets:
 - 1. Install the automated external defibrillator (AED) cabinets in Terminal 4 Station, the 44th Street Station, and the East Economy Lot Station in the locations indicated in the Contract Documents.



2. Ensure that the automated external defibrillator (AED) cabinets are properly installed in all respects, including, but not limited to, their form, fit, and function.
 - a. The installed automated external defibrillator (AED) cabinets must satisfy not only the specified location requirements for the cabinets, but must be fully compliant with the American with Disabilities Act (ADA) requirements specified.
 - b. Connect the automated external defibrillator (AED) cabinets to the Phoenix Sky Harbor International Airport phone switch.

B. Systems Integration:

1. Phoenix Sky Harbor International Airport Responsibilities:
 - a. The Phoenix Sky Harbor International Airport is responsible for providing conduit, cabling, and cable terminations for the automated external defibrillator (AED) cabinet's security tie-in and pressure switch provided under this Section.
 - b. Implementation of the following functions is the responsibility of the Phoenix Sky Harbor International Airport:
 - 1) Upon activation of a closed circuit television (CCTV) camera by a signal from an automated external defibrillator (AED) cabinet's security signal or pressure switch, the video display of the camera must automatically be displayed on the monitor selected, and the location information of the automated external defibrillator (AED) must be displayed at the bottom of the monitor.
 - a) If more than one automated external defibrillator (AED) cabinet's security or pressure switch signal is activated, multiple monitors will be used, and/or split screen features will be activated.
 - 2) Archiving the video of the activated cameras' images until the activating automated external defibrillator (AED) cabinet's security or pressure switch signal is deactivated.
 - 3) Upon activation of an automated external defibrillator (AED) cabinet's security or pressure switch signal, sending location information through the existing phone switch, and displaying the location information on the operator phones.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the automated external defibrillators (AEDs) are being installed, the Testing and Inspection Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.



- 1) The Phoenix Sky Harbor International Airport will coordinate integrated test requirements.
- b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
- c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Inspections:
 - a. Ensure that all connections to the automated external defibrillators (AEDs) are completed properly.
- B. Non-Conforming Work
 1. Correct the discrepancies or problems discovered during these inspections at no increase in Contract Price.

3.05 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 CLOSEOUT ACTIVITIES

- A. Training:
 1. Train the Owner's maintenance personnel to adjust, operate, and maintain the automated external defibrillators (AEDs) in accordance with the requirements specified in Section 01770, Closeout Procedures.
 - a. The Phoenix Sky Harbor International Airport will provide adequate training facilities for each training session.
- B. Record Documentation:
 1. The Phoenix Sky Harbor International Airport will provide electronic background drawings to be used to prepare Record Drawing submittals.
 2. Legibly mark the Record Drawing documents and as-built Shop Drawings to record the actual automated external defibrillators (AEDs) installation, including communication conduit, cabling and pathways used, field changes of dimensions and details, changes in details from those indicated on the Contract Drawings, details not on the original Contract Drawings, and the make and model of the actual products installed.
 - a. Base the as-built locations of the call stations on the final installation.
 3. Submit the Record Drawing documents and as-built Shop Drawings for the automated external defibrillators (AEDs) to the Program/Project Manager for review.



- a. Should additional information or revisions be required, the reviewed documents will be returned to the Contractor for correction and re-submittal to the Program/Project Manager.

3.07 MAINTENANCE

- A. Operation and Maintenance Data:
 1. Prepare Operation and Maintenance Manuals for the automated external defibrillators (AEDs).
 2. Submit the Operation and Maintenance Manuals for the automated external defibrillators (AEDs) to the Project/Project Manager.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 12484

ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for entrance floor mats and frames.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADAAG: Americans with Disabilities Act Accessibility Guidelines.
 - 2. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - b. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. U. S. Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)].
 - b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - c. United States Access Board:
 - 1) Accessibility Guidelines for Buildings and Facilities (ADAAG), <https://www.access-board.gov/guidelines-and->



[standards/buildings-and-sites/113-ada-standards/background/adaag/422-a-guide-to-adaag-provisions.](#)

4. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate installation of the entrance floor mat and frame with the placement of the floor to ensure that embedments are installed properly

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Floor mats.
 - 2) Recessed frames.
 - b. Shop Drawings:
 - 1) Shop Drawings of the entrance floor mats and frames.
 - c. Samples:
Entrance floor mat Samples.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Sustainable Design Submittals:
 - 1) Indoor Chemical & Pollutant Source Control, Submittal for entrance floor mats and frames.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance data for the entrance floor mats and frames.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Accessibility Requirements:



- a. Comply with the requirements of Section 4.5 in the U.S. Architectural and Transportation Barriers Compliance Board's "Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities".
- B. Sustainability Standards Certifications:
 - 1. Indoor Chemical & Pollutant Source Control Submittal:
 - a. For permanent entrance floor mats and frames at least 10 feet long in the primary direction of travel at regular entry points for building users, submit Product Data noting that these products qualify the Project to claim Indoor Chemical & Pollutant Source Control.
- C. Site Samples:
 - 1. Entrance Floor Mat Samples:
 - a. Submit Samples for each floor mat, tread rail, and frame member to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. JL Industries, Inc., www.jlindustries.com.
 - b. American Floor Products Company, Inc., www.afco-usa.com.
 - c. Arden Architectural Specialties, Inc., <http://www.designguide.com/profileDetail.aspx?lid=50917>.
 - d. Balco, Inc., www.balcousa.com.
 - e. Flexco, www.flexcofloors.com.
 - 2. Substitution Limitations:
 - a. Basis-of-Design Product:
 - 1) JL Industries, Inc., Model JL-906P Serrated Top Rail Surface Grating in 900 series JL-L.
 - b. Subject to compliance with the Contract requirements, provide entrance floor mats and frames equivalent in size, function, and quality to the basis of design product specified from the manufacturers listed.
 - 3. Product Options:
 - a. Product Data:
 - 1) Submit Product Data for each type of product specified and proposed for the Work of this Section.
- B. Regulatory Requirements:
 - 1. Accessibility Requirements:



- a. Provide installed floor mats that comply with Section 4.5 in the United States Access Board's Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG).

C. Design Criteria:

1. Shop Drawings:

- a. Submit Shop Drawings of the entrance floor mats and frames to the Program/Project Manager for approval, and showing the following:
 - 1) Items penetrating floor mats and frames.
 - 2) Divisions between mat sections.
 - 3) Perimeter floor moldings.

D. Materials:

1. Extruded Aluminum Treads:

- a. Provide full length extruded aluminum rails with serrated treads assembled with keylock bars spaced 3 inches apart on center and extruded vinyl cushions spaced 24 inches apart on center.
- b. Tread Width: 5/8 inch.
- c. Rail Spacing: 1/8 inch.
- d. Rail Finish: Mill finish.
- e. Wheel Load: 1500 pounds.

2. Recessed Frames:

- a. Provide recessed frames fabricated from extruded aluminum Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 complying with the requirements specified in ASTM B 221 or ASTM B 221M.

2.02 SHOP FABRICATION:

A. Floor Mats:

1. Fabricate the floor mat units in the shop to the greatest extent possible.
2. Unless otherwise indicated, provide a single unit of the size indicated on the Contract Drawings for each mat installation.
 - a. Do not exceed the manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning.
3. Where joints in mats are necessary, space the joints symmetrically and away from normal traffic lanes.

B. Recessed Frames:

1. Fabricate the floor mat frames for permanent recessed installation as indicated on the Contract Drawings, complete with corner pins or reinforcement and anchorage devices.
2. Fabricate edge-frame members in single lengths or, where the frame dimensions exceed the maximum available lengths, provide the minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.



3. Miter corner joints in framing elements with hairline joints, or provide prefabricated corner units without joints.

2.03 FINISHES:

- A. Coat the surfaces of aluminum frames that will come into contact with cementitious material with the manufacturer's standard protective coating.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify that the entrance floor mat frame installation has been properly coordinated with placement of the floor.

3.02 INSTALLATION

- A. Install recessed mat frames according to the manufacturer's written installation instructions.
 1. Submit the entrance floor mat and frame manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Set the mat tops at the height recommended by the manufacturer for the most effective cleaning action.
- C. Coordinate the top of the mat surfaces with the bottoms of the doors that swing across the mats to provide clearance between the door and mat.

3.03 PROTECTION

- A. After completing installing the frame and concrete work, provide a temporary filler of plywood or fiberboard in the recesses, and cover the frames with plywood protective flooring.
- B. Maintain protection until construction traffic has ended and Contract is near Substantial Completion.

3.04 MAINTENANCE

- A. Maintenance Data:
 1. Submit maintenance data for the entrance floor mats and frames provided.
 2. Maintenance Service:
 - a. Roll-out mats will only qualify the Project for Indoor Chemical & Pollutant Source Control when maintained weekly by a contracted service organization.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition



SECTION 13100

LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing the lightning protection system for buildings or structures as indicated on the Contract Drawings and attachments to this Section.
 - a. The work covered under this Section of the specifications consists of furnishing the labor, materials, and services required for the completion of this portion of the PHX Sky Train Project's lightning protection system.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. LPI: Lightning Protection Institute.
 - 2. PHX/LRT: PHX Sky Train/Light Rail Transit.
 - 3. NRTL: National recognized testing laboratory.
- B. Reference Standards:
 - 1. Lightning Protection Institute (LPI):
 - a. LPI 175 - Lightning Protection Institute Installation Code.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
 - 3. NSF International (NSF):
 - a. ANSI/NSF 60 Drinking Water Treatment Chemicals – Health Effects.
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. UL 96 - Standard for Lightning Protection Components.
 - b. UL 96A - Standard for Standard for Installation Requirements for Lightning Protection Systems.
 - c. UL 467 - Standard for Grounding and Bonding Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring,



supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Sequencing:

1. Portions of the lightning protection system's uppermost down conductor to air terminals will be left incomplete until the future completion of the uppermost portion of the buildings or structures.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Backfill for chemical ground rods.
 - 2) Concrete-encased electrodes.
 - 3) Exo-thermionic welded connectors.
 - 4) Ground loop conductors.
 - 5) Ground rods.
 - 6) Inspection well enclosures.
 - 7) Lightning down conductor.
 - 8) Warning tape.
 - b. Shop Drawings:
 - 1) Lightning protection system.
 - c. Certificates:
 - 1) Evidence of UL Master Label Certification for the System.
 - 2) Evidence of Lightning Protection Institute (LPI) Master Certification for the System.
 - d. Qualification Statements:
 - 1) Qualifications of the lightning protection system installer firms and personnel.

B. Informational Submittals:

1. Submit the following to the Construction Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Site Quality Control Submittals:
 - 1) Copy of the LPI Certified System Application form.

C. Closeout Submittals:

1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Manufacturer's warranty for the chemical ground rods.
 - b. Record Documentation:



- 1) As-built drawings for the lightning protections system.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Listing and Labeling:
 - a. Obtain the listing and labeling for the system as defined in the "Definitions" Article in NFPA 780.
- B. Qualifications:
 1. Installer Qualifications:
 - a. Engage an experienced installer who is a nationally recognized testing laboratory (NRTL), or who is certified by the Lightning Protection Institute (LPI) as a Master Installer Designer.
 - b. The installing Subcontractor must be UL-listed as a Lightning Protection Installer.
 - c. Submit the qualifications of the lightning protection system installer firms and personnel demonstrating their capabilities and experience to the Program Manager for approval.
 - 1) Include listing or certification data by an NRTL or by LPI.
- C. Certifications:
 1. UL Master Label Certification:
 - a. Upon completion of the Work, obtain a UL Master Label System "C" Certification.
 - b. Submit evidence of obtaining the UL Master Label for the System to the Program Manager for approval.
 2. Lightning Protection Institute (LPI) Master Certification:
 - a. After the system receives a UL Master Label System "C" Certification, obtain a LPI-177 System Master Certification for the system.
 - b. Submit evidence of obtaining the LPI-177 System Master Certification for the System to the Program Manager for approval.

1.06 WARRANTY

- A. Manufacturer Warranty:
 1. Provide a 30-year maintenance free manufacturer's warranty for the chemical ground rods.
 2. Submit the warranty documents to the Program Manager as part of Contract closeout.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturer List:



1. Harger Lightning Protection, Inc., www.harger.com.
2. Heary Bros. Lightning Protection Co. Inc., www.hearybros.com.
3. National Lightning Protection Corporation, www.theprotectionsource.com.
4. Thompson Lightning Protection, Inc., www.tlpinc.com.
5. Lyncole Industries, Inc., www.lyncol.com.
6. Erico® International Corporation, www.erico.com.

B. Substitution Limitations:

1. Subject to compliance with the requirements specified herein, other manufacturers' products may be incorporated into the Work.

2.02 DESIGN CRITERIA:

- A. Design the entire lightning protection system in accordance with LPI 175, NFPA 780, and UL 96A.
- B. Provide components for the lightning protection system that comply with the requirements specified in UL 96.
 1. Provide only UL approved materials listed for Lightning Protection Systems.
 2. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.
- C. Prepare and submit Shop Drawings of the lightning protection system to the Program manager for approval.

2.03 MATERIALS:



Propulsion Building Ground Rod

- A. Chemical Ground Rods:
 1. Provide UL-listed chemical ground rods complying with the requirements of UL 467, consisting of Type K copper tubes filled with non-hazardous self-moisturizing salts (Calsolyte), and having a minimum life expectancy of 50 years.
 - a. Nominal Tube Wall Thickness: 0.083 inch.
 2. Provide chemical ground rods having either straight configurations as detailed in the "Straight Shaft Grounding System Detail" shown on sheet GND-2, or L-shaped configurations as detailed in the "L-Shaped Shaft Grounding Detail" shown on sheet GND-3, both attached to the end of this Section.
 3. Backfill for Chemical Ground Rods:
 - a. Provide an electrically conductive, natural clay backfill material based on volcanic action, which when mixed with water becomes a slurry capable of being pumped or poured around the electrodes installed within enclosures in the ground.
 - b. Provide backfill that is approved by and listed in ANSI/NSF 60.



4. Manufacturers:
 - a. Lyncole Industries, Inc., XIT™ Grounding System, www.lyncol.com.
 - b. Approved equal.
- B. Exo-Thermionic Welded Connectors:
 1. Provide molds, thermite packages, and other material for exo-thermionic welds that are full-rated to carry 100 percent of the cable rating, and which are letter-coded exo-thermionic welded type.
 - a. Provide the exo-thermionic welding materials from a single manufacturer throughout the Project.
 2. Provide items for connections of cable to ground-rod.
 3. Manufacturers:
 - a. Erico® International Corporation, Cadweld®, www.erico.com.
 - b. Approved equal.
- C. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes:
 1. Provide ground rods, ground loop conductors, and concrete-encased electrodes complying with the requirements specified in NFPA 780.
 2. Provide conductors with protective coatings for use where conditions would cause deterioration or corrosion of conductors.
- D. Lightning Down Conductor:
 1. Provide NFPA Class I copper lightning down conductors.
 2. Provide conductors with protective coatings for use where conditions would cause deterioration or corrosion of conductors.

2.04 ACCESSORIES

- A. Inspection Well Enclosure:
 1. Provide a high density reinforced polymer concrete inspection well enclosure rated for a maximum load of 10,000 pounds.
 2. Provide a bolt-down cover for the inspection well enclosure.
 3. Manufacturer:
 - a. Erico® International Corporation, Eritech®, No. T416A, www.erico.com.
 - b. Approved equal.
- B. Warning Tape:
 1. Provide 4-mil thick, minimum, polyethylene plastic warning tape overcoated with printed graphics that read, "CAUTION-BURIED ELECTRIC LINE".
 2. Provide red colored tape in accordance with the APWA Uniform Color Code as described in the APWA Public Works Management Practices Manual.
 3. Manufacturers:
 - a. Brady Worldwide, Inc., No. 11296, www.bradyid.com.
 - b. Seton Identification Products, www.seton.com.



- c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A, LPI 175, and NFPA 780 standards for lightning protection systems.
- B. Install conductors with direct paths from air terminals to ground connections.
 - 1. Avoid sharp bends and narrow loops.
- C. Conceal the following conductors.
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors normally within view from exterior locations at grade that are within 200 feet of buildings, platforms, and walkways.
- D. Cable Connections:
 - 1. Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.
- E. Bond the extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- F. Install down conductors in the vertical pre-cast vertical columns, and bond the conductors to the reinforcing steel at the uppermost and lowermost points of the column reinforcing steel.
- G. Install the ground grid cable as detailed in the "Ground Grid Cable Trench" detail shown on sheet GND-8 attached to the end of this Section; and install chemical ground rods as detailed in the "Straight Shaft Grounding System Detail" shown on sheet GND-2 attached to the end of this Section.
- H. Where practical, interconnect ground loop conductors for adjacent columns using approved connection methods.
- I. Special Techniques:
 - 1. The ground loop required by NFPA 780 may be a counterpoise installation provided the counterpoise conductor meets or exceeds the minimum requirements stipulated in NFPA 780.
 - a. Bond ground terminals to the counterpoise conductor.
 - b. Bond grounded metal bodies on the building or structure that are within 12 feet of ground to the counterpoise conductor.



3.02 FIELD QUALITY CONTROL

- A. Inspections:
 - 1. Inspect the lightning protection system as required by the referenced standards and the Program Manager.
 - a. Arrange the UL inspections required to obtain the UL Master Label System "C" Certification.
 - b. Prepare and submit the LPI Certified System Application form to LPI to obtain system certification, and submit a copy to the Program Manager for information.
 - 2. Prepare and submit as-built drawings of the lightning protection system as installed to the Program Manager for approval.

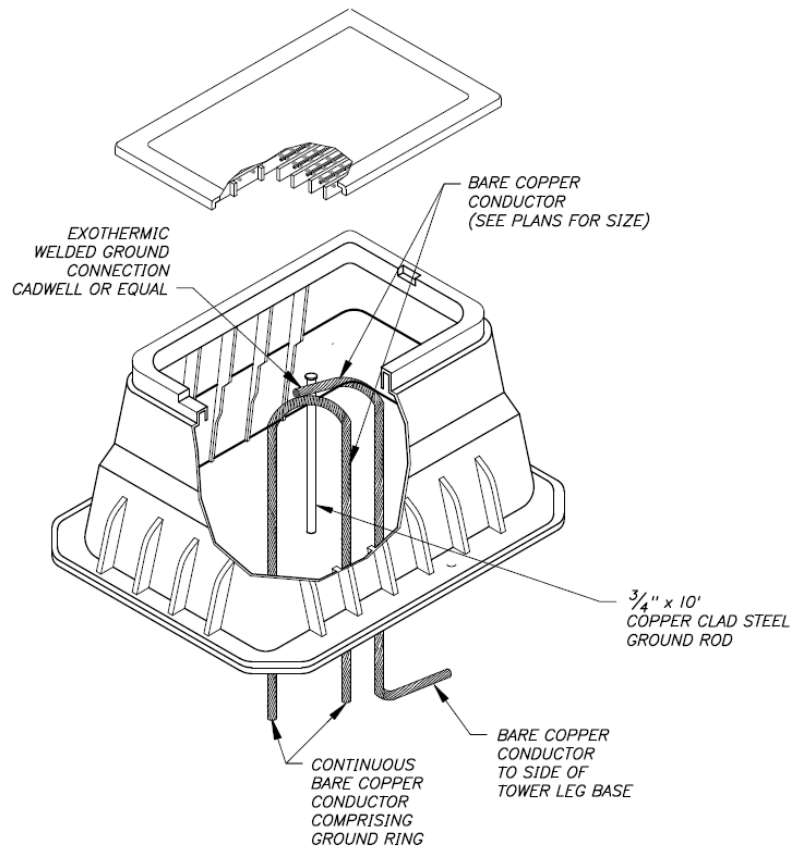
3.03 PROTECTION

- A. Provide protection for the down conductor tails or stubs provided for the future completion of the uppermost portion of structures so the down conductors will be accessible and usable at that future time.

3.04 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
 - 1. GND-1 Automated Train Stage Two Design]- Cable to Ground Rod Connection.
 - 2. GND-2 Automated Train Stage Two Design – Straight Shaft Grounding System Detail.
 - 3. GND-3 Automated Train Stage Two Design – L-Shaped Shaft Grounding Detail.
 - 4. GND-4 Automated Train Stage Two Design – Air Terminal Mounting Detail.
 - 5. GND-5 Automated Train Stage Two Design – Cable to Ground Rod Connection.
 - 6. GND-6 Automated Train Stage Two Design –Ground Test Well Detail.
 - 7. GND-7 Automated Train Stage Two Design – Grounding Detail.
 - 8. GND-8 Automated Train Stage Two Design – Ground Grid Cable Trench.
 - 9. GND-9 Automated Train Stage Two Design – Grounding Cable to Ground Rod Connection.
 - 10. GND-10 Automated Train Stage Two Design – Grounding Detail.
 - 11. GND-11 Automated Train Stage Two Design – Grounding Detail.
 - 12. GND-12 Automated Train Stage Two Design – Grounding Detail.
 - 13. GND-13 Automated Train Stage Two Design – Grounding Detail.

END OF SECTION



CABLE TO GROUND ROD CONNECTION
NTS

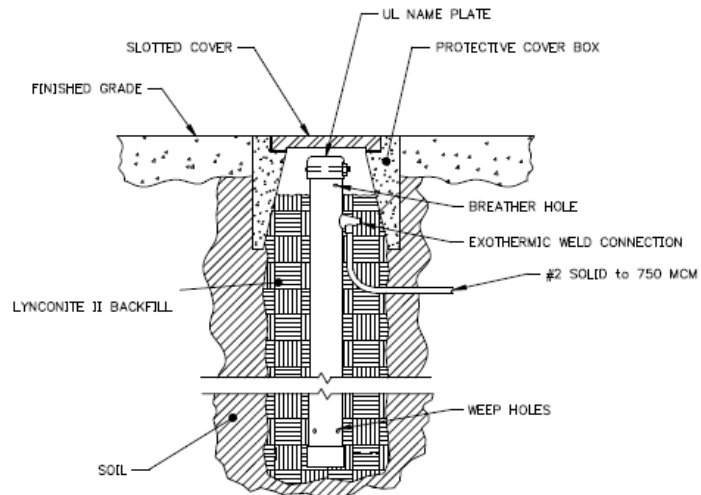


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AUTOMATED TRAIN STAGE TWO DESIGN
CABLE TO GROUND ROD CONNECTION

GND-1

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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LYNCOLE XIT GROUNDING SYSTEM

STRAIGHT SHAFT MODEL: INFORMATION & SPECIFICATIONS

- A. Shaft configuration: Straight. Standard lengths: 10', 12', & 20', or custom.
- B. UL and CSA Listing: 467.
- C. ISO 9000 Certified
- D. Lynconite II backfill meets a highly conductive natural clay backfill that is ANSI/NSF Environmental Standard 60.
- E. Material: Type K Copper 0.083" nominal wall thickness.
- F. Construction: Hollow tube, 2.125" O.D., filled with non-hazardous salts (Calsolyte).
- G. Weight: 3.5 lbs per lineal foot.
- H. Ground Wire Termination: Exothermic connection to conductors from #2 solid AWG to 750 MCM. U-bolt with pressure plate provided as test point.
- I. Minimum Life Expectancy: 50 years. Warranty: 30 years.
- J. Straight Shaft Model No: K2-10CS, K2-12CS, K2-20CS.

CHEMICAL GROUND ROD

NTS

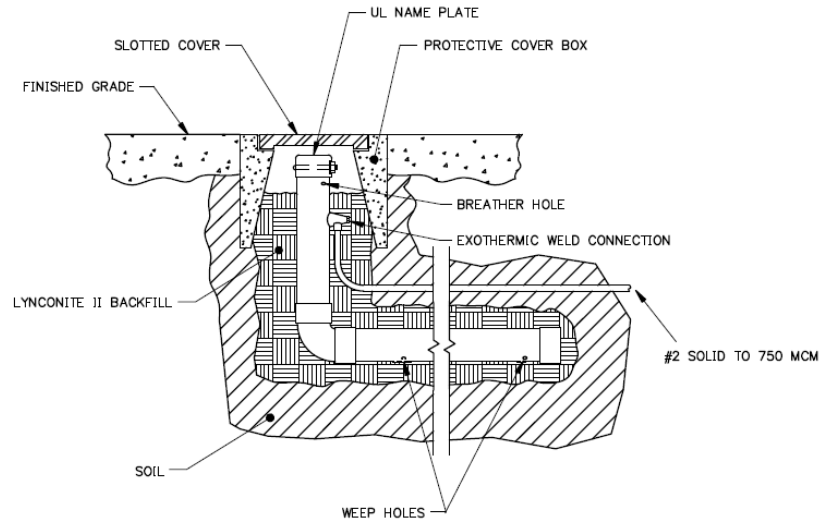


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AUTOMATED TRAN STAGE TWO DESIGN
STRAIGHT SHAFT GROUNDING SYSTEM DETAIL

GND-2

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LYNCOLE XIT GROUNDING SYSTEM

L-SHAPED MODEL: INFORMATION & SPECIFICATIONS

- A. Shaft configuration: L-shaped. Standard lengths: 10', 12', & 20', or custom.
- B. UL and CSA Listing: 467.
- C. ISO 9000 Certified
- D. Lynconite II backfill meets ANSI/NSF Environmental Standard 60.
- E. Material: Type K Copper 0.083" Nominal wall thickness
- F. Construction: Hollow tube, 2.125" O.D., filled with non-hazardous salts (Calsolyte).
- G. Weight: 3.5 lbs per lineal foot.
- H. Ground Wire Termination: Exothermic connection to conductors from #2 solid AWG to 750 MCM. U-bolt with pressure plate provided as test point.
- I. Minimum Life Expectancy: 50 years. Warranty: 30 years
- J. L-shaped Model No: K2L-10CS, K2L-12CS, K2L-20CS.

SHALLOW CHEMICAL GROUND ROD

NTS

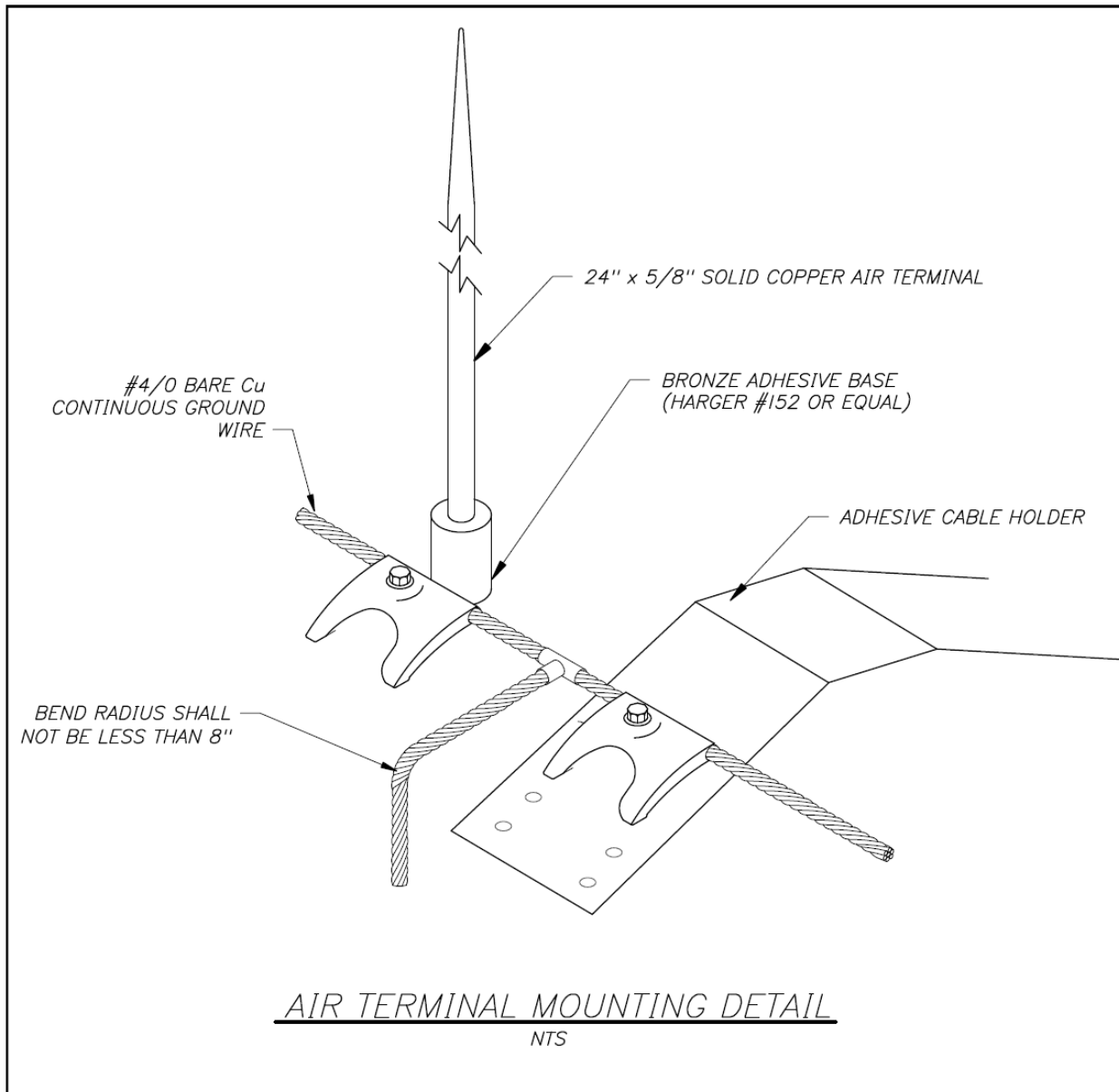


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AUTOMATED TRAIN STAGE TWO DESIGN
L- SHAPED SHAFT GROUNDING DETAIL

GND-3

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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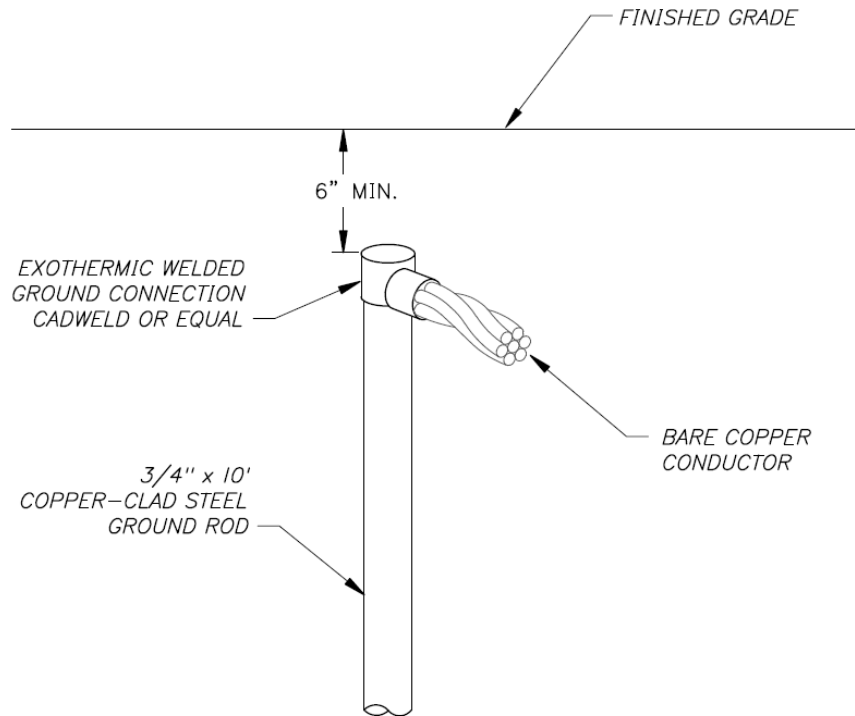


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AUTOMATED TRAIN STAGE TWO DESIGN
AIR TERMINAL MOUNTING DETAIL

GND-4

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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CABLE TO GROUND ROD CONNECTION
NTS

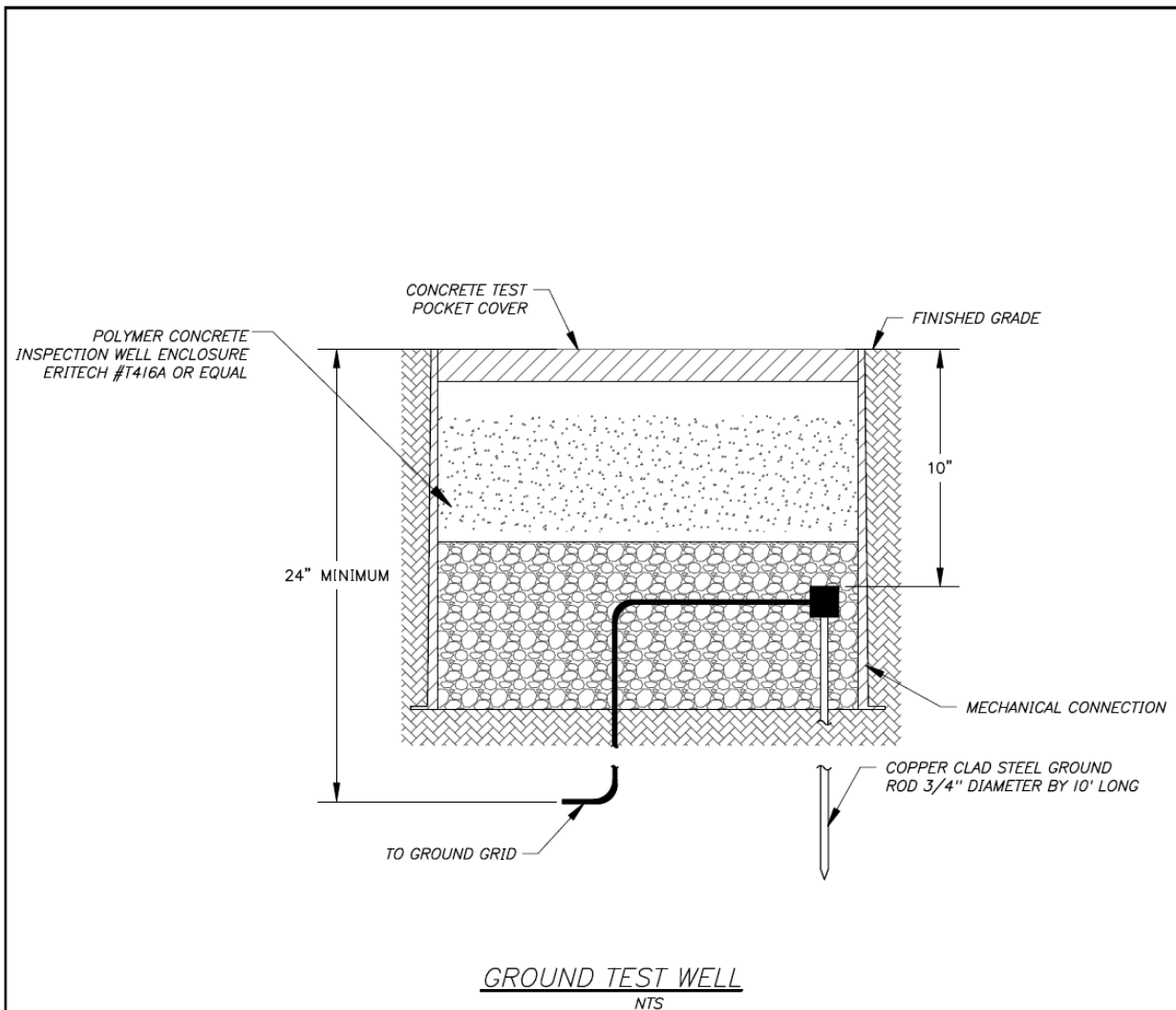


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AUTOMATED TRAIN STAGE TWO DESIGN
CABLE TO GROUND ROD CONNECTION

GND-5

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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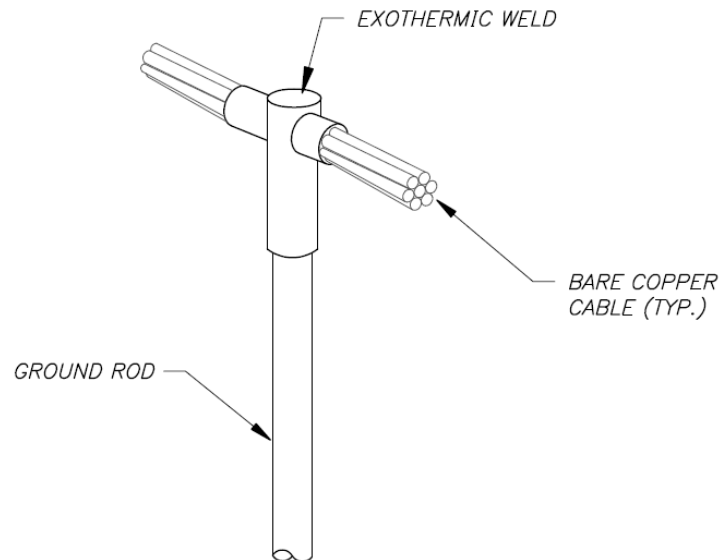


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUND TEST WELL DETAIL

GND-6

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID THROUGH CABLE TO TOP OF GROUND ROD

NTS

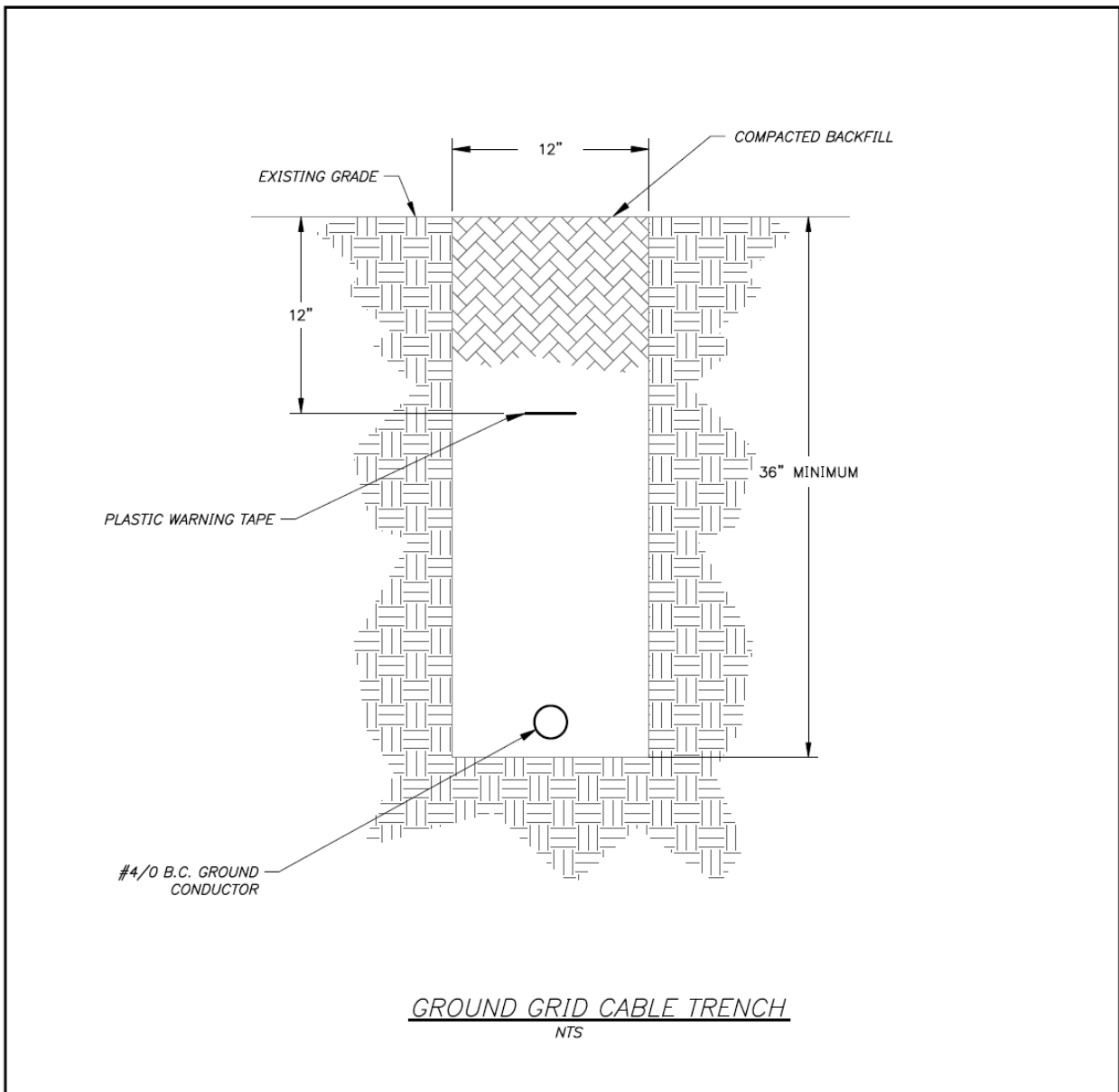


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING DETAIL

GND-7

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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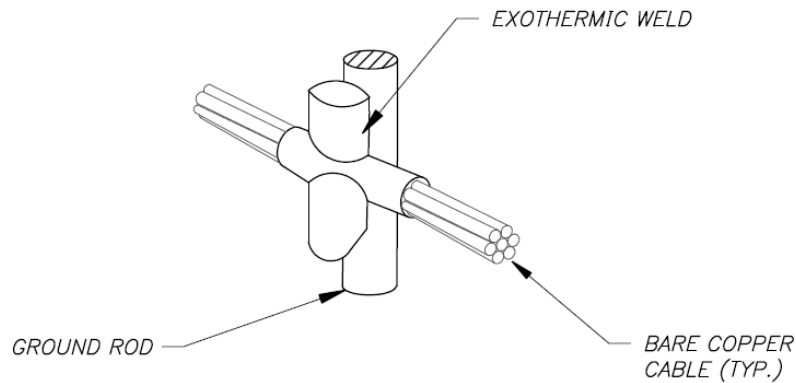


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUND GRID CABLE TRENCH

GND-8

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID THROUGH CABLE TO SIDE OF GROUND ROD
NTS

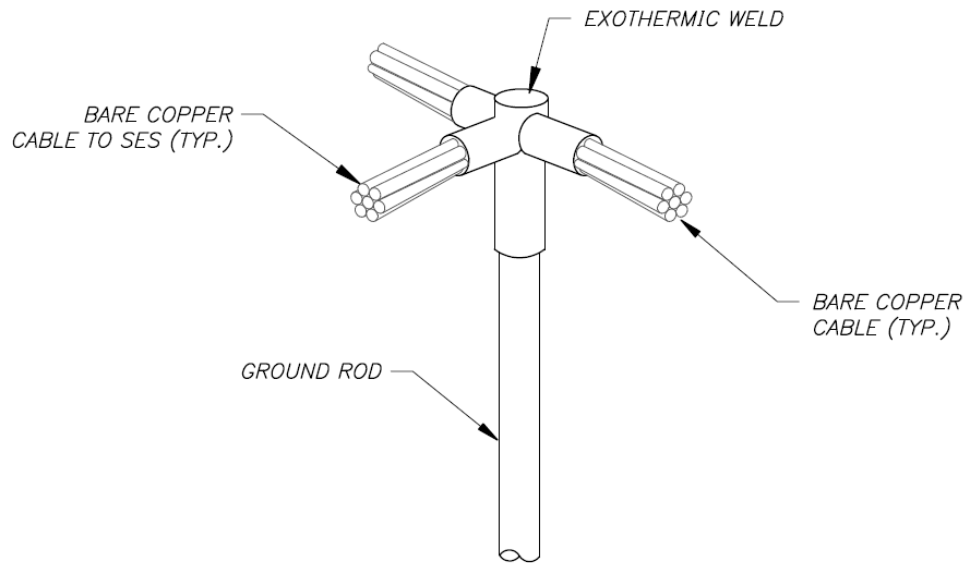


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING CABLE TO GROUND ROD CONNECTION

GND-9

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID TEE OF HORIZONTAL RUN
AND TAP CABLES TOP OF GROUND ROD
NTS

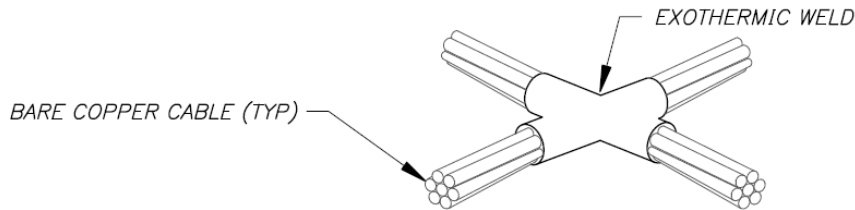


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING DETAIL

GND-10

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID CROSS OF HORIZONTAL
CABLES, TAP CABLE CUT

NTS

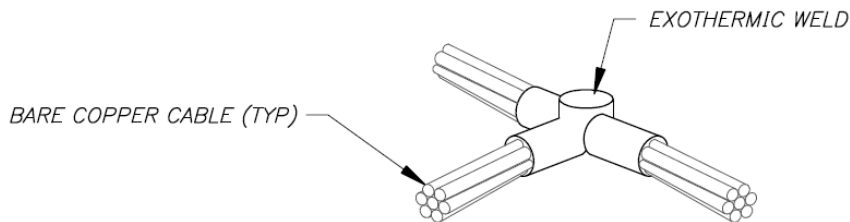


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING DETAIL

GND-11

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID TEE OF HORIZONTAL RUN AND TAP CABLES

NTS

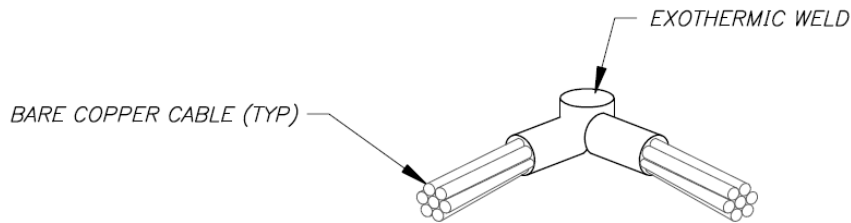


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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING DETAIL

GND-12

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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GROUND GRID "L" OF HORIZONTAL RUN AND TAP CABLES
NTS



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AUTOMATED TRAIN STAGE TWO DESIGN
GROUNDING DETAIL

GND-13

PROJECT NO. 06107	DATE 7/08	DESIGNED WW	DRAWN BY KS	CHECKED CA
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REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 13453

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following for monitoring and control of electrical power system:
 - 1. PC-based workstation(s) and software.
 - 2. Communication network and interface modules for RS-232 data transmission protocols.
- B. Related Sections:
 - 1. Division 16 Section "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

1.02 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- C. HTML: Hypertext markup language.
- D. I/O: Input/output.
- E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- F. LAN: Local area network; sometimes plural as "LANs."
- G. LCD: Liquid crystal display.
- H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- I. Modbus TCP/IP: An open protocol for exchange of process data.



- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. PC: Personal computer; sometimes plural as "PCs."
- L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. THD: Total harmonic distortion.
- Q. UPS: Uninterruptible power supply; used both in singular and plural context.
- R. WAN: Wide area network.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
- B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
 - 5. UPS sizing calculations for workstation.
 - 6. Surge suppressors: Data for each device used and where applied.



- C. Software and Firmware Operational Documentation:
 - 1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
 - 2. Software operating and upgrade manuals.
 - 3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
 - 4. Device address list and the set point of each device and operator option, as set in applications software.
 - 5. Graphic file and printout of graphic screens and related icons, with legend.
- D. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.
- E. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
- F. Qualification Data: For qualified manufacturer.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Operating and applications software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
 - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
- I. Other Informational Submittals:
 - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.



- B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.06 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.07 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
 - 2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.



PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Schweitzer Engineering Laboratories, Inc (SEL) or equivalent.

2.02 FUNCTIONAL DESCRIPTION

- A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
 - 1. Calculate and Record the Following:
 - a. Load factor.
 - b. Peak demand periods.
 - 2. Measure and Record Metering Data for the Following:
 - a. Electricity.
- B. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
 - 1. Voltage regulation and unbalance.
 - 2. Continuous three-phase rms voltage.
 - 3. Periodic max./min./avg. voltage samples.
 - 4. Harmonics.
 - 5. Voltage excursions.
 - 6. Current excursions.
- C. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:
 - 1. Determine system topology.
 - 2. Evaluate remaining loads and sources.
 - 3. Shed loads in less than 100 ms.
- D. Demand Management:
 - 1. Peaking or co-generator control.
 - 2. Load interlocking.
 - 3. Load shedding.
 - 4. Load trimming.
- E. System: Report equipment status and power system control.

2.03 SYSTEM REQUIREMENTS

- A. Monitoring and Control System: Include multiple PC-based workstations with graphics capability and Web access, with its operating system and application software, connected to data transmission network.



- B. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- D. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.
 - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor, voltage, and current.
 - 2. Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.04 OPERATING SYSTEM

- A. Software: Configured to run on a portable laptop computer, a single PC, or a palm computer, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.
- B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Modbus TCP/IP, RS-232, and RS-485 digital communications.
- C. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Ethernet, Modbus TCP/IP, RS-232, and RS-485 digital communications.
- D. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.



- E. Operating System Software: Based on 32-bit, Microsoft Windows workstation operating system. Software shall have the following features:
 - 1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
 - 2. Graphical user interface to show pull-down menus and a menu tree format.
 - 3. Capability for future additions within the indicated system size limits.

2.05 APPLICATIONS SOFTWARE

- A. Basic Requirements:
 - 1. Fully compatible with and based on the approved operating system.
 - 2. Password-protected operator login and access; three levels, minimum.
 - 3. Password-protected setup functions.
 - 4. Context-sensitive online help.
 - 5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
 - 6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
 - 7. Automatic and encrypted backups for database and history; automatically stored at central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
 - 8. Operator audit trail for recording and reporting all changes made to user-defined system options.
- B. Workstation Server Functions:
 - 1. Support other client PCs on the LAN.
 - 2. Maintain recorded data in databases accessible from other PCs on the LAN.
- C. Data Formats:
 - 1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
 - 2. Option to convert reports and graphics to HTML format.
 - 3. Interactive graphics.
 - 4. Option to send preprogrammed or operator designed e-mail reports.
- D. Metered Data: Display metered values in real time.
- E. Remote Control:
 - 1. Display circuit-breaker status and allow breaker control.
 - 2. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of



metered demands, utility contracted load shedding, or combinations of these.

- F. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
- G. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
 - 1. Site plan.
 - 2. Floor plans.
 - 3. Equipment elevations.
 - 4. Single-line diagrams.
- H. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:
 - 1. Operator log on/off.
 - 2. Attempted operator log on/off.
 - 3. All alarms.
 - 4. Equipment operation counters.
 - 5. Out-of-limit, pickup, trip, and no-response events.
- I. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
 - 1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
 - 2. Charting, statistical, and display functions of standard Windows-based spreadsheet.
- J. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
 - 1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.
- K. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event. Include the graphic displays of the following, based on user-specified criteria:
 - 1. Phase voltages, phase currents, and residual current.
 - 2. Overlay of three-phase currents, and overlay each phase voltage and current.
 - 3. Waveforms ranging in length from 2 cycles to 5 minutes.
 - 4. Disturbance and steady-state waveforms up to 512 points per cycle.
 - 5. Transient waveforms up to 83,333 points per cycle on 60-Hz base.



6. Calculated waveform, based on recorded data, on a minimum of four cycles of data of the following:
 - a. THD.
 - b. rms magnitudes.
 - c. Peak values.
 - d. Crest factors.
 - e. Magnitude of individual harmonics.
- L. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
 1. Tabular data shall be in the comma-separated values.
- M. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
 1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
 2. Sort and report by device name and by function.
 3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
 4. Differentiate alarm signals from other indications.
 5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.06 COMMUNICATION COMPONENTS AND NETWORKS

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.07 POWER MONITORS

- A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.
 1. Enclosure: NEMA 250, Type 3R.
- B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
- C. rms Real-Time Measurements:
 1. Current: Each phase, neutral, average of three phases, percent unbalance.



2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
 3. Power: Per phase and three-phase total.
 4. Reactive Power: Per phase and three-phase total.
 5. Apparent Power: Per phase and three-phase total.
 6. Power Factor: Per phase and three-phase total.
 7. Displacement Power Factor: Per phase and three-phase total.
 8. Frequency.
 9. THD: Current and voltage.
 10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
- D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Peak.
- E. Demand Real Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- F. Demand Reactive Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- G. Demand Apparent Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.



5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- H. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:
1. Last completed interval.
 2. Coincident with kW peak.
 3. Coincident with kVAR peak.
 4. Coincident with kVA peak.
- I. Power Analysis Values:
1. THD, Voltage and Current: Per phase, three phase, and neutral.
 2. Displacement Power Factor: Per phase, three phase.
 3. Fundamental Voltage, Magnitude and Angle: Per phase.
 4. Fundamental Currents, Magnitude and Angle: Per phase.
 5. Fundamental Real Power: Per phase, three phase.
 6. Fundamental Reactive Power: Per phase.
 7. Harmonic Power: Per phase, three phase.
 8. Phase rotation.
 9. Unbalance: Current and voltage.
 10. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.
- J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
 2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
 - b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
 3. Demand Calculation Initiated by a Synchronization Signal:
 - a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Demand can be synchronized with clock in the power meter.



- K. Sampling:
1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
 2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
- L. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
1. Line-to-line voltage.
 2. Line-to-neutral voltage.
 3. Current per phase.
 4. Line-to-line voltage unbalance.
 5. Line-to-neutral voltage unbalance.
 6. Power factor.
 7. Displacement power factor.
 8. Total power.
 9. Total reactive power.
 10. Total apparent power.
 11. THD voltage L-L.
 12. THD voltage L-N.
 13. THD current.
 14. Frequency.
- M. Harmonic Calculation: Display and record the following:
1. Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
 2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.
- N. Current and Voltage Ratings:
1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
 2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
 3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
- O. Accuracy:
1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:



- a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
 - b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
 - c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
 - d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
 2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:
 - a. Current: Plus or minus 2.5 percent.
 - b. Voltage: Plus or minus 1.5 percent.
 - c. Energy, Demand, and Power: Plus or minus 4.0 percent.
 - d. Frequency: Plus or minus 1 Hz.
- P. Waveform Capture:
1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
 2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.
- Q. Input: One digital input signal(s).
1. Normal mode for on/off signal.
 2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
 3. Conditional energy signal to control conditional energy accumulation.
- R. Outputs:
1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
 2. Closed in either a momentary or latched mode as defined by user.
 3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
 4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
 5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
 6. Output Relay Control:
 - a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
 - b. Normally open and normally closed contacts, field configured to operate as follows:
 - 1) Normal contact closure where contacts change state for as long as signal exists.



- 2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
- 3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
- 4) End of power demand interval when relay operates as synchronization pulse for other devices.
- 5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
- 6) Output controlled by multiple alarms using Boolean-type logic.

S. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 800 KB of onboard nonvolatile memory.
2. Stored Data:
 - a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 and 52 days of 15-minute interval data, depending on number of quantities selected.
 - b. Custom Data Logs: One user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
 - 1) Schedule interval.
 - 2) Event definition.
 - 3) Configured as "fill-and-hold" or "circular, first-in first-out."
 - c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
 - d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

T. Alarms.

1. User Options:
 - a. Define pickup, dropout, and delay.
 - b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
 - c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
2. Alarm Events:
 - a. Over/undercurrent.
 - b. Over/undervoltage.
 - c. Current imbalance.



- d. Phase loss, current.
- e. Phase loss, voltage.
- f. Voltage imbalance.
- g. Over kW demand.
- h. Phase reversal.
- i. Digital input off/on.
- j. End of incremental energy interval.
- k. End of demand interval.

U. Control Power: 90- to 457-V ac or 100- to 300-V dc.

V. Communications:

- 1. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.
- 2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

2.08 STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT

- A. Separately mounted, permanently installed instrument for power monitoring and control.
 - 1. Enclosure: NEMA 250, Type 3R.
- B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
 - 1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
- C. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.
- D. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via LAN.
- E. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.
- F. Server Configuration:



1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
 2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
 3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
 4. Operating Software: Suitable for local access; firewall protected.
- G. Data Access:
1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.
- H. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.
- I. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
1. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values.
 2. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
 3. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
 4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
 5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
 6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
 7. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
 8. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
 9. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
 - a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
 - b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user



selectable. Time interval to be displayed on scale shall be for previous day or week.

10. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.

J. Communications:

1. Power monitor: Permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.
2. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.

2.09 WORKSTATION HARDWARE

A. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

B. Computer: Standard unmodified PC of modular design, designed for the latest version of Windows operating system.

1. Memory: minimum of 1 GB of usable installed memory.
2. Real-Time Clock. Automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
3. Ports: Two RS-232-F serial ports for general use; one parallel port; four USB ports
4. Replaceable graphics board.
5. LAN Adapter Card.
6. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
7. Color Monitor: WXGA TFT, not less than 18 inches (455 mm), LCD type.
8. Keyboard: US English.
9. Mouse: Standard.
10. Minimum Disk Storage: 100 GB, 7200 rpm hard drive.
11. CD-RW/DVD-ROM Drive.
12. Report Printer: Minimum resolution 600 dpi laser printer.
 - a. Connected to central station and designated workstations.
 - b. RAM: 2 MB, minimum.
 - c. Printing Speed: Minimum 12 pages per minute.
 - d. Paper Handling: Automatic sheet feeder with 250-sheet paper cassette and with automatic feed.

C. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and



data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.

- D. UPS: Self-contained; complying with requirements in Division 16 Section "Static Uninterruptible Power Supply."
 - 1. Size: Provide a minimum of 6 hours of operation of workstation station equipment.
 - 2. Batteries: Sealed, valve regulated, recombinant, lead calcium.
 - 3. Accessories:
 - a. Transient voltage suppression.
 - b. Input-harmonics reduction.
 - c. Rectifier/charger.
 - d. Battery disconnect device.
 - e. Static bypass transfer switch.
 - f. Internal maintenance bypass/isolation switch.
 - g. External maintenance bypass/isolation switch.
 - h. Output isolation transformer.
 - i. Remote UPS monitoring.
 - j. Battery monitoring.
 - k. Remote battery monitoring.

2.10 RS-232 ASCII INTERFACE

- A. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
- B. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
 - 1. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
- C. Alarm System Interface:
 - 1. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
- D. Cables:
 - 1. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield



coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

- a. NFPA 70, Type CMR.
 - b. Flame Resistance: UL 1581, Vertical Tray.
2. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. NFPA 70, Type CMP.
 - b. Flame Resistance: NFPA 262, Flame Test.

2.11 LAN CABLES

- A. Comply with Division 16 Section "Communications Horizontal Cabling."
- B. RS-485 Cable:
 1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMR.
 2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
- C. Unshielded Twisted Pair Cables: As specified for horizontal cable for data service in Division 16 Section "Communications Horizontal Cabling."

2.12 LOW-VOLTAGE WIRING

- A. Comply with Division 16 Section "Control-Voltage Electrical Power Cables."
- B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
 2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
 3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation



tolerances, hazards to cable installation, and other conditions affecting installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CABLING

- A. Comply with NECA 1.
- B. Install cables and wiring according to requirements in Division 16 Section "Communications Horizontal Cabling."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
- F. Install cables without damaging conductors, shield, or jacket.

3.03 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
- B. Label each power monitoring and control module with a unique designation.

3.04 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.



- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Electrical Tests: Use caution when testing devices containing solid-state components.
 - 2. Continuity tests of circuits.
 - 3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
 - a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
 - b. Test LANs according to requirements in Division 16 Section "Communications Horizontal Cabling."
 - c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
 - d. Verify accuracy of graphic screens and icons.
 - e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
 - f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
- E. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.



- H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- I. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- J. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.06 DEMONSTRATION

- A. Train owner's maintenance personnel to adjust, operate, and maintain systems. See Division 1 Section "Demonstration and Training."
 - 1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
 - 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.07 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 16215

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition.



SECTION 13852

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. System smoke detectors.
 - 3. Heat detectors.
 - 4. Notification appliances.
 - 5. Magnetic door holders.
 - 6. Remote annunciator.
 - 7. Addressable interface device.
 - 8. Network Connection.

1.02 GENERAL DESCRIPTION

- A. This section covers addressable fire alarm systems as they relate to building detection, alarm, and notification; as well as interconnection with wet pipe automatic sprinkler systems, and other building features.

1.03 RELATED WORK

- A. It is the contractor's responsibility to consult other specification sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete operational installation.

1.04 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.05 REFERENCES

- A. NFPA 70, National Electric Code – 2011
- B. NFPA 72, National Fire Alarm and Signaling Code – 2013
- C. International Building Code (IBC) – 2012 with City of Phoenix amendments
- D. International Fire Code (IFC) – 2012 with City of Phoenix amendments



1.06 QUALIFICATIONS

- A. Designer Qualifications: Shop drawings and calculations must be prepared and submitted for approval by a minimum NICET Level III certified technician.
- B. Installer Qualifications: Project Manager or Office Superintendent must be a minimum NICET Level II certified technician.
- C. All design work shall be performed by a NICET Level III or IV certified fire alarm technician or a registered Fire Protection Engineer.
- D. The installing contractor shall be a firm with a minimum three years documented experience installing fire alarm systems and providing contract maintenance service as a part of their business.

1.07 SCOPE OF WORK

- A. The work includes the installation of necessary Signaling Line Circuits (SLC), Notification Appliance Circuits (NAC), data gathering panels and interconnection to the emergency communication system, for an operational fire detection, alarm, and emergency communication system.
- B. Install audio racks as necessary.
- C. Furnish and install all automatic and manual detection equipment.
- D. Interface the new XLS 3000 FACU with all Releasing Control Units supervising double interlock pre-action systems.
- E. The scope of work also includes training City of Phoenix personnel on the operation of the system, required maintenance tasks and frequencies, and the locations of all equipment necessary to maintain and operate the fire alarm system.
- F. The scope of work includes open discussion and frequent updates on the equipment progress with HAJV and the Owner.
- G. The Designer's scope of work includes the submission of a Designer's Narrative Report that includes the following minimum content. The Narrative Report is a project- specific statement of how the designer has captured the project requirements for a fire alarm system. minimum content in the Narrative Report is:
 - 1. Basis of Design
 - 2. Sequence of Operations
 - 3. Matrix of Operations
 - 4. Specialized FP Equipment (including sequence of operation)
 - 5. System Testing Requirements



- H. Fire detection and alarm systems shall be configured using the XLS 3000 Honeywell system.
- I. Install the necessary digital and voice contact closures for each PA system amplifier.
- J. Install the necessary equipment to supervise the Processor “house PA” system amplifier power and signal outputs for each amplifier.
- K. Furnish and install all necessary control modules for the automatic operation of the fire/smoke dampers, elevator recall, elevator power shunt trip, HVAC dampers, and HVAC shutdown.
- L. Furnish and install all necessary monitor modules for supervision of the emergency generator, duct detectors and double interlock preaction system alarm, supervisory, and trouble signals.
- M. Furnish and install monitor modules to supervise the emergency generator: on-off-auto, low fuel, battery fault, generator fault, generator run, ATS.
- N. All duct detectors shall be supervised by the fire alarm system. Contractor shall consult the mechanical drawings for the number of duct detectors.
- O. Include in the shop drawing development the functional description of the audible and visual alerting signals as detailed in the Risk Analysis.
- P. The audio portion of the Emergency Communications Systems is being used to function similar to an emergency voice/alarm communications system (EVACS), which is required by the 2012 IBC, including City of Phoenix Amendments, for high-occupancy assembly buildings [2012 IBC, 907.2.1.1 & 907.5.2.2]. The operational requirements for EVACS by NFPA 72 will provide the necessary levels of protection, reliability, and functionality commensurate with other fire alarm equipment, and will improve upon the level of protection currently afforded the system. Furnish and install all the necessary control and monitor modules for the “house PA” system monitoring by the FACU to indicate status, off normal conditions, operation, and power availability.
- Q. Furnish and install the necessary equipment so that the visual strobe notification appliances have the capability of being manual activated from the Comm Center or the FCC. The system shall have the capability of activating the strobe visual notification appliances without the broadcast of an alarm signal from the FACU or a manual voice message. The visual strobe notification appliances shall be able to be activated independently of any alarm, trouble, or supervisory signal.
- R. Interface the XLS3000 FACU to the smoke control system and fire fighter’s smoke control override panel.



1.08 SUBMITTALS

- A. Prior to performing any work, the contractor shall include the following documentation in addition to those documents required elsewhere in this specification:
1. A schedule indicating the delivery dates of the equipment to be supplied, installation sequence, time frame and the total amount of on-site technical assistance time (in man-hours per phase), and final acceptance test dates to meet the scheduled project completion dates.
 2. A preliminary equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list shall include the type, quantity, make and model of spare equipment, as specified in this specification. Types and quantities of equipment submitted shall coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings. A final equipment list shall be submitted with the Operating and Maintenance (O&M) manual, as specified in this specification.
 3. If the contractor is also the designer of the fire alarm system, provide a sequence of operation that describes how the system responds during alarm, supervisory, and trouble conditions. The description shall include FACP LEDs, audible, and visible indications; as well as initiating devices, notification appliances, and auxiliary functions (such as HVAC fan unit shutdown, etc.). The description shall provide sufficient information so that the exact function of each installed device and appliance is known.
 4. Manufacturer's original product datasheets, specifications, installation instruction sheets, and descriptive information for all major components of the system shall be provided. Copies are not acceptable. All equipment and devices to be furnished under this contract shall be clearly marked (highlighted) on the product datasheets.
 5. Submit manufacturer's specification sheets for the type of conductor and/or wiring planned for use.
 6. Provide data sheets for the manufacturer of the UL listed through-penetration fire stop assembly.
 7. A complete list of amperage requirements during normal, supervisory, trouble, and alarm conditions for each component of the system.
 8. Preliminary battery calculations showing total standby power and total alarm power required meeting the specified system requirements. Final battery calculations shall be submitted with the O&M manual, as specified in this specification.



9. Preliminary system voltage drop calculations to assure that the system shall operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards. Final voltage drop calculations shall be submitted with the O&M manual and as-built drawings.
 - a. Voltage drop calculations can be performed with negligible inductance.
 - b. The voltage drop calculations shall take into consideration the resistance in ohms of one circular mil foot of conductor in the calculations. Information on this can be found in Chapter 9, Table 8 of NFPA 70.
 10. Test Plan must be submitted three weeks prior to the scheduled date of the Acceptance Test for review and approval by the project manager.
 11. Smoke control system panel layout.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72, Appendix A-7.5.2.2, and complete listing of software required.
 3. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 4. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 5. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
 6. Circuits layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; and notification appliance circuit drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated
- C. Field quality-control reports.
- 1.09 AS-BUILT DRAWINGS
- A. Any changes to the designed location of notification appliances and detection devices shall be approved prior to installation. Additionally, the as-built drawings shall show how the cable and conduit has been routed and the location of all



terminal and junction boxes. The as-builts shall account for all field changes that were made during the installation.

- B. The contractor shall develop a matrix of operations for each detection device (point), grouped for each building, which shows the device address, location, and function.
- C. The contractor shall show the equipment and addresses associated with each device, as listed in this specification, on a separate layer and provide copies of only this layer shown on the floor plans as part of the set of as-built drawings.
- D. Upon completion of the installation of the system and a minimum of one week prior to the Acceptance Test, the contractor shall deliver two complete sets of reproducible, full-size, appropriately scaled, as-built drawings to the project manager.
- E. One set of red line as-built drawings will be maintained at the main FACP at all times. Drawings shall indicate True North and Plan North.

1.010 TEST PLAN

- A. Upon completion of the installation of each system and a minimum of two weeks prior to the Acceptance Test, the contractor shall deliver two complete sets of the Test Plan, which shall describe how the system shall be tested. This shall include a systematic description of all tests and shall indicate type and location of test apparatus to be employed. All tests shall be conducted in the presence of the project manager and other parties identified by the owner or owner's representative and shall not be conducted until the Test Plan is approved.

1.011 OPERATION AND MAINTENANCE MANUALS

- A. The following shall be provided to the owner:
 - 1. Comply with the Records Section of the Inspection, Testing and Maintenance Chapter of NFPA 72.
 - 2. Provide Record of Completion Documents according to NFPA 72, *Permanent Records* in the Records Section of the *Inspection, Testing and Maintenance* chapter.
 - 3. Record copy of site-specific software.
 - a. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - b. Software operating and upgrade manuals.
 - c. Device address list.
 - d. Printout of software application
 - 4. Provide Maintenance, Inspection and Testing Records according to NFPA 72 and include the following:
 - a. Software operating and upgrade manuals.



- b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals
 - 5. Manufacturer's required maintenance related to system warranty requirements.
 - 6. Abbreviated operating instructions for mounting at FACP.
- B. Software and Firmware Operational Documentation:
- 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.012 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.013 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.014 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.



3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no less than 1 unit of each type.
5. Keys and Tools: One extra set for access to lock and tamper proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. This specification identifies the essential functional requirements of the automatic networked fire alarm system(s) for installation. The manufacturer's equipment (hardware and software) and system configuration shall comply with or exceed the functional intent of this specification.
- B. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specifications or drawings shall be promptly identified to the Owner in the form of an RFI.

2.02 QUALIFICATION OF MANUFACTURERS

- A. Acceptable manufacturers:
 1. Honeywell – no equal.
 2. Listed and compatible peripheral devices and appliances.

2.03 QUALITY ASSURANCE

- A. Each component of the networked fire alarm system shall be listed as a product of a single fire alarm system manufacturer under the appropriate category for the intended use by Underwriters Laboratories, Inc. (UL) and shall bear the "UL label". All control equipment shall be listed under UL category UOJZ FACUs System as a single unit. Partial listings, or multiple listings for various major sections of the control equipment, shall not be acceptable. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the AHJ.
- B. All control equipment shall have transient protection devices that comply with the requirements outlined in UL 864, Standard for FACUs for Fire-Protective Signaling Systems.
- C. All materials and equipment supplied shall be new, first quality and the manufacturer's best type and latest model capable of complying with all



requirements of this specification and shall have been in continuous production and in continuous service in commercial applications for at least one year. Obsolete equipment shall not be used.

2.04 FUNCTIONAL DESCRIPTION OF THE SYSTEM

A. Alarm Condition

1. The FACU shall have a SYSTEM ALARM LED and an alarm signal ACKNOWLEDGE switch.
 - a. An alarm signal shall cause the transmission of an alarm signal from the control unit to the Central Command Center.

B. Supervisory Condition

1. The FACU shall have a SYSTEM SUPERVISORY LED and a supervisory signal ACKNOWLEDGE switch.
 - a. An off-normal operation condition shall cause the transmission of a supervisory signal from the valve to the building fire alarm control unit.

C. Trouble Condition

1. The FACU shall have a SYSTEM TROUBLE LED and a trouble signal ACKNOWLEDGE switch.
2. Unacknowledged alarm messages shall have priority over trouble messages, and, if such an alarm occurs during a trouble sequence, the alarm condition shall have display priority.
 - a. A circuit ground or short condition shall cause the transmission of a trouble signal from the valve to the building fire alarm control unit

D. System Supervision

1. All wiring extending from the FACU shall be supervised for opens, shorts, and grounds. Systems containing unsupervised wiring of any type shall not be acceptable.
2. The occurrence of any fault shall activate the system trouble circuitry, but shall not interfere with the proper operation of any circuit that does not have a fault condition.

E. Signal Transmission

1. All signals shall annunciate at the remote alarm annunciator and the FACU.
2. All signals shall be transmitted via network connection to the Airport Command Center.

2.05 MINIMUM COMPONENTS

- A. The automatic fire detection and alarm system relocation and installation shall consist of, but not be limited to:
 1. Addressable monitor modules and control relay output modules.



2. Addressable smoke detectors over control equipment. Where the environment is not suitable for a smoke detector, replace with an addressable heat detector.
3. Monitoring of tamper and flow switches on all fire protection systems.
4. Monitoring of alarm, supervision and trouble for all releasing control panels.
5. Annunciation at the fire command center.
6. New XLS3000 FACU and audio racks.
7. Interface to the Emergency Communication System (PA).
8. Output modules for the voice recorded message and for manual voice override.

2.06 SYSTEM FIELD DEVICES - GENERAL

- A. Connection of initiating devices and notification appliances to appropriate signaling line circuits and notification appliance circuits from each zone.
- B. Devices shall operate under the following ranges of environmental conditions:
 1. Ambient Temperature: 32-100 degrees Fahrenheit.
 2. Relative humidity: 0-93 percent, non-condensing.
 3. Air velocity: 300 feet per minute.
- C. Each addressable device shall include a means to assign a unique address code to the device in the field. This address code shall serve as the means by which the system program recognizes the device.
- D. The address of each addressable device shall be clearly and permanently indicated on the base of each detector or on the face of monitor modules, control relay output modules, and manual fire alarm boxes.
- E. Failure of any single device shall not hinder the operation of any other devices connected to the signaling line circuit.
- F. Failure of the FACU to properly communicate with any addressable device shall initiate the proper trouble sequence. While in this trouble condition, the FACU shall cause actual alarm input from devices to override trouble alarm.

2.07 AUTOMATIC DETECTORS - GENERAL

- A. Automatic smoke detectors located over control equipment shall be of the addressable, analog photoelectric type and shall be interchangeably mounted into a common twist-lock base.
- B. Make safe automatic detectors located in the construction area shall be conventional 136 degree Rate of Rise heat detectors.



2.08 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS

- A. Comply with UL 268; operating at 24-V dc, nominal.
- B. Photoelectric smoke detectors shall have a general alarm setting in all common spaces of 3.0% - 4.0% per foot obscuration.
- C. The detectors shall provide a combination alarm/power LED. The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the FACU. The LED shall be placed into steady illumination under an alarm condition. An output connection shall also be provided in the base to connect an external remote alarm LED.

2.09 ADDRESSABLE SMOKE DETECTORS

- A. Detectors shall have a general alarm setting in all common spaces of medium sensitivity.
- B. The detectors shall provide a combination alarm/power LED. The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the FACU. The LED shall be placed into steady illumination under an alarm condition. An output connection shall also be provided in the base to connect an external remote alarm LED.
- C. Beam Detectors
 - 1. Xtralis OSID or pre-approved equal

2.010 ADDRESSABLE DUCT SMOKE DETECTORS

- A. Photoelectric type complying with UL 268A.
- B. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
- C. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
- D. Each sensor shall have multiple levels of detection sensitivity.
- E. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- F. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit



2.011 HEAT DETECTORS

- A. Comply with UL 521.
- B. Heat Detector, Rate of Rise-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F

2.012 DETECTOR BASES

- A. Automatic detectors shall utilize a common, plug-in, twist-lock, tamper-resistant type base that accommodates photoelectric and thermal detectors. Detectors shall be interchangeable to simplify field conversion.
- B. Removal of the detector from the base shall cause a trouble indication at the FACU. Removal of the detector shall not disrupt the alarm circuit wiring or prevent the receipt of alarms from other devices operating in the circuit.

2.013 ADDRESSABLE MONITOR MODULES

- A. Furnish and install addressable monitor modules to supervise and monitor the status of each non-addressable device, such as the make safe heat detectors.
- B. Each addressable monitor module shall be able to support any number of normally open (N/O) devices. Wiring to the device(s) being monitored shall be Class B. Module status (normal, alarm, supervisory, trouble) shall be transmitted to the FACU.
- C. An LED shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the FACU.

2.014 ADDRESSABLE CONTROL MODULES

- A. Furnish, install, and relocate addressable control modules for auxiliary control of fire protection equipment.
- B. An LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and in regular communication with the FACU.

2.015 WIRE GAUGE

- A. Unless otherwise indicated on the design drawings or manufacturer's specifications, the following minimum sizes of conductors shall be used for all new wiring:



- | | |
|--|------------|
| 1. Power Supply Conductors (Primary and Secondary) | No. 12 AWG |
| 2. Signaling Line Circuit Conductors | No. 14 AWG |
| 3. Notification Appliance Circuit Conductors | No. 14 AWG |
| 4. LCD Remote Alarm Annunciators | No. 14 AWG |

- B. All Conductors shall be plenum rated as described in NFPA 70.

2.016 VISUAL STROBE NOTIFICATION APPLIANCES

- A. Provide UL-listed visible (Strobe) notification appliances complying with the requirements specified in NFPA 72, UL 1971, Americans with Disabilities Act Accessibility Guidelines (ADAAG), and the Uniform Federal Accessibility Standards (UFAS).
- B. All visual strobe notification appliances will be marked with the word "ALERT" on the body. The text shall either be in the color red or white depending upon the selection of the appliance color by the architect.

2.017 REMOTE ANNUNCIATOR

- A. Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
- B. Mounting: Flush cabinet, NEMA 250, Type 1

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The supervisory work of the qualified manufacturer's technical representative shall include, but not necessarily be limited to, checking all the system wiring connections; advising the contractor regarding technical details of the installation; and the adjustment and testing of all components of the system in order to ensure a complete and satisfactorily operable system. The manufacturer's technical representative shall be on site, during the entire installation and connection of the new control equipment. The technical representative shall monitor all wiring changes and assist the contractor to ensure a smooth transition to the new control equipment. The cost of the technical representative shall be paid by the contractor and shall be included in the bid price.
- B. All relays for control devices shall be located within 36" of the device.



- C. Smoke detectors shall not be installed until after the construction clean-up of all trades is complete and final.
- D. Automatic Detectors
 - 1. In general, automatic detectors shall be mounted on the structural ceiling or finished ceiling and not on the bottom or side of any type of construction or structure, which extends down from the ceiling unless otherwise shown on the contract drawings.
 - 2. Automatic detectors shall be located near points where air currents normally intersect. Detectors shall not be located in the direct path of the draft from an HVAC air supply grille, a door, window, or hallway. Detectors shall be installed a minimum of three feet from an HVAC air supply diffuser, in accordance with NFPA 72.
- E. Addressable Photoelectric Smoke Detectors
 - 1. Addressable analog photoelectric smoke detectors shall be spaced at maximum of 30 foot on center and in accordance with NFPA 72 and the manufacturer's installation instructions. Smoke detectors shall only be installed in those environments suitable for proper smoke detector operation.
 - 2. Install detectors over control equipment. The detectors shall be installed no more than 48-inches above the panels.
- F. Addressable Monitor Modules
 - 1. Addressable monitor modules shall include a mounting plate for installation in a junction box or shall be mounted in a locked cabinet or approved box, as shown on the manufacturers recommended specifications.
- G. Addressable Control Modules
 - 1. Addressable control modules shall include a mounting plate for installation in a junction box or shall be mounted in a locked cabinet or approved box, as shown on the manufacturers recommended specifications. Install in a weather proof backbox in exterior locations.

3.02 WIRING

- A. All wiring shall comply with this section.
- B. The entire wiring and raceway system for the networked fire alarm systems shall be in full accordance with NFPA 70.
- C. The contractor shall furnish all metal raceway, wiring, outlet boxes, junction boxes, cabinets, labels and similar devices necessary for the complete installation of the fire alarm systems. All wiring shall be of the type as specified herein and recommended by the manufacturer and shall be installed in metal raceway throughout in accordance with NFPA70.



- D. Raceways containing conductors identified as Fire Alarm System conductors shall not contain any other conductors, and no AC carrying conductors shall be allowed in the same raceway with the DC fire alarm detection and signaling conductors.
- E. Where a circuit is modified, the conductor shall be installed terminal to terminal. No splicing permitted.
- F. All existing wiring shall be tested for abnormal conditions (grounds, shorts, opens, etc.) prior to reuse. In general, existing initiating device circuits shall be reused as signaling line circuits if the circuit is not loaded to more than 80% of the available circuit loading and the distance limitations as set forth by the manufacturer's recommended specifications are not exceeded. In the event that a signaling line circuit or a notification appliance circuit load exceeds 80% of the available circuit loading, new circuits shall be installed.
- G. All wiring shall test free from grounds and short circuit faults. No connections to the FACU shall be made until the system wiring has been accepted by the Owner.
- H. Unless otherwise indicated, the color code for all fire alarm conductors shall be as follows:
 - 1. Signaling line circuits and initiating device circuits shall be red and black. Red shall be positive and black shall be negative.
 - 2. Sprinkler/standpipe circuits shall be red and black. Red shall be positive and black shall be negative.
 - 3. Detector and monitor module power circuits shall be brown and violet. Violet shall be positive and brown shall be negative.
- I. All fire alarm conductors shall be installed per NFPA 70. Minimum conduit size, if used, is $\frac{3}{4}$ ". All conduits in occupied areas shall be concealed, unless otherwise approved in writing by the Owner.
- J. All junction and pull box covers shall be red. Label all conduits at 20-foot increments, Fire Alarm or approved equal, in red letters. Alternatively, install red colored EMT.
- K. Exposed raceways shall be run parallel and perpendicular to the walls and ceilings. Wherever practical, exposed raceways shall be run on the ceiling as close as possible to a wall or as high as possible on a wall. Where exposed raceways shall cross under a structural beam or rib, they shall be run down on one side of the beam or rib, across its bottom, and up to the ceiling on the other side of the beam or rib. No spanning from beam to beam or rib to rib shall be permitted. The use of a raceway body on one side of a beam or rib shall be permitted provided it shall be readily accessible. Where metal raceway is installed exposed, it shall be painted to match the walls and/or ceilings on which it is installed, as instructed by the Owner. The method and location of all exposed raceways shall be approved by the Owner prior to start of any installation work.



- L. The power employed to operate the fire alarm systems shall have a high degree of reliability and capacity for the intended service. Connections to this power service shall be made on a dedicated branch circuit(s). The circuit shall be mechanically protected and identified as "Fire Alarm".
- M. All wiring within the FACU shall be neatly served in the panel gutters and be secured by approved means.
- N. All conductors and EMT shall be installed in a neat and workman-like manner. Vertically and horizontally positioned EMT and/or conductors shall be supported in accordance with good tradesman practices and including, but not limited to, the NEC Sections 376 and 378.
- O. Where penetrations of floor slabs, fire-resistance rated walls, or smoke barrier walls are made; the wiring shall be sleeved in metal raceway and the penetrations shall be fire-stopped with approved or UL listed through-penetration firestop assembly material acceptable to the Owner.
- P. Each SLC and NAC emanating from the FACU shall be installed in a Class B configuration.
- Q. Arrange and zone each detection and supervision device to annunciate the floor in which it is located upon actuation.

3.03 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.04 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.05 ACCEPTANCE TESTING

- A. Prerequisites to the Acceptance Test:
 - 1. Submittal of a Test Plan for approval by the Owner (three weeks prior to proposed test date).
 - 2. Completion of tests on all components in accordance with the Test Plan by contractor and manufacturers' reps.
 - 3. Submittal of as-built drawings.



- B. Before the installation will be considered complete and acceptable by the Owner, the entire system must pass a Pre-Acceptance Test. This test shall be coordinated and performed by the contractor, in the presence of a representative of the manufacturer, and the Owner. The test shall not be conducted until all parties agree on the scheduled test date.
 - 1. The pre-acceptance test shall be performed on all detection devices and notification appliances. The pre-acceptance testing shall be performed in accordance with the applicable sections of NFPA 72.
- C. The contractor shall provide all the necessary personnel and equipment to conduct the tests.
- D. The Contractor shall schedule the Pre-Acceptance test at least one week in advance. The Contractor shall not perform the test without the required parties. The required parties are the Owner, and the AHJs.
- E. At a minimum, the contractor shall perform the following:
 - 1. Operate every building fire alarm device to ensure proper operation, correct annunciation at each remote annunciator (as shown on the drawings) and at the FACU, and proper operation of all supervisory and alarm functions.
 - 2. The signaling line circuits shall be opened in at least two locations per floor to check for the presence of correct supervisory circuitry.
 - 3. One-half of all tests shall be performed on battery/emergency generator standby power.
- F. Once the Pre-Acceptance test has been completed and results accepted by the Owner, the Contractor shall schedule a Final Acceptance Test.
 - 1. The final acceptance test shall be performed on all detection devices and notification appliances. The final acceptance testing shall be performed in accordance with the applicable sections of NFPA 72.
- G. The contractor shall provide all the necessary personnel and equipment to conduct the tests.
- H. The Contractor shall schedule the Pre-Acceptance test at least one week in advance. The Contractor shall not perform the test without the required parties. The required parties are the Owner, and the AHJs.
- I. At a minimum, the contractor shall perform the following:
 - 1. Operate 100% of the building fire alarm devices to ensure proper operation, correct annunciation at each remote annunciator and at the FACU, and proper operation of all supervisory and alarm functions
 - 2. The signaling line circuits shall be opened in at least two locations per floor to check for the presence of correct supervisory circuitry.
- J. One-half of all tests shall be performed on battery standby power.



- K. If the Final Acceptance Test fails, the contractor shall pay all costs incurred to the Owner for any and all reacceptance testing.
- L. Upon satisfactory completion of the tests, the contractor shall leave the fire alarm systems (if installed) in proper working order and without additional expense to the Owner, shall replace any defective materials or equipment provided by the contractor under this contract within two years from the date of final acceptance by the awarding authority.

3.06 TRAINING REQUIREMENTS

- A. After final acceptance of the fire alarm system, the contractor and supplier shall provide operation training to City of Phoenix Aviation Department personnel. Each training session shall be a minimum of one hour and shall be conducted on shift or at a time acceptable to the building's operators. Each session shall include an overview of the system and the devices connected to it, emergency procedures (including alarm, trouble and supervisory condition procedures), FACU operation, and safety requirements. Each session shall include a complete demonstration of the system. Dates and times of each training period shall be coordinated through the Owner, not less than two weeks prior to the training session.

3.07 CLEANING AND ADJUSTING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit(s) internally using methods and materials recommended by manufacturer.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First Edition
1	03/30/2018	N/A	1.07, 1.08, 2.05, 2.07, 2.09, 2.18	Jensen Hughes Edits.



SECTION 13859

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. This section covers the minimum requirements for the mass notification and emergency communications systems to be installed and interfaced with station SCADA and FACP systems at the 24th Street Station and the Rental Car Center Station, including, but not limited to the following:
 - a. Evacuation and mass notification loudspeakers
 - b. Ambient sense microphones
 - c. Audio digital signal processors
 - d. Loudspeaker amplifiers
 - e. Amplifier switchers

B. Related Sections:

1. Section 01325 – Progress Schedules and Reports
2. Section 01330 – Submittal Procedures
3. Section 01780 – Closeout Submittals
4. Section 13453 – Supervisory Control and Data Acquisition (SCADA)
5. Section 13852 – Digital, Addressable Fire-Alarm System

1.02 REFERENCES

A. Abbreviations and Acronyms

1. ACS: Announcement Control System
2. ANSI: American National Standards Institute
3. BICSI: Building Industry Consulting Services International
4. COPAD: City of Phoenix Aviation Department
5. DEC: Department of Environmental Conservation
6. ECS: Emergency Communication System.
7. EIA: Electronics Industry Association
8. ER: Equipment Room
9. FCC: Federal Communications Commission
10. FM: Factory Mutual
11. IEEE: Institute of Electrical and Electronics Engineers
12. ISO: International Standards Organization
13. NEC: National Electrical Code
14. NEMA: National Electrical Manufacturers' Association
15. NESC: National Electrical Safety Code
16. NFPA: National Fire Protection Association
17. OSHA: Occupational Safety and Health Administration
18. PIPS: Passenger Information and Paging System



- 19. TIA: Telecommunications Industry Association
- 20. TR: Telecommunications Room
- 21. UFBC: Uniform Fire Prevention and Building Code
- 22. UL: Underwriter's Laboratories, Inc.

B. Definitions

- 1.

C. Reference Standards

- 1. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of the telecommunications industry, as well as federal, state and local governmental agencies, including, but not limited to the following:
 - a. NFPA 70, National Electric Code – 2011
 - b. NFPA 72, National Fire Alarm and Signaling Code – 2013
 - c. UL 1424 Underwriters Laboratories Standard for Safety –Cables for Power-Limited Fire-Alarm Circuits
 - d. UL 1480 Underwriters Laboratories Standard for Safety – Speakers for Fire Alarm and Signaling Systems, Including Accessories
 - e. UL 1863 Underwriters Laboratories Standard for Safety – Communications Circuit Accessories
 - f. UL 2043 Underwriters Laboratories Standard for Safety – Fire test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
 - g. UL 2196 Underwriters Laboratories Standard for Safety – Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.
 - h. International Building Code (IBC) – 2012 with City of Phoenix amendments
 - i. International Fire Code (IFC) – 2012 with City of Phoenix amendments
 - j. CFR 47 Part 15 Radio Frequency Devices
 - k. EIA-160 Sound Systems
 - l. EIA-219 Audio Facilities for Radio Broadcasting Systems
 - m. ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements, 02/02/09
 - n. ANSI/TIA/EIA –569-B Commercial Building Standard for Telecommunications Pathways and Spaces, May 2009
 - o. ANSI/TIA/EIA -606-A Administration Standard for Commercial Telecommunications Infrastructure, 11/24/08
 - p. ANSI/TIA/EIA -607 Commercial Building Grounding and Bonding Requirements for Telecommunications, August 1994
 - q. ANSI/TIA/EIA – 862 Building Automation Systems Cabling Standard for Commercial Buildings, 2002
 - r. FCC 47 Part 68 Code of Federal Regulations, Title 47, Telecommunications
 - s. IEC 60849 Sound Systems for Emergency Purposes



- t. IEEE National Electrical Safety Code (NESC); 2007
- u. ISO/IEC 11801 Information Technology - Generic Cabling for Customer Premises
- v. LADBS Los Angeles Department of Building and Safety - City of Los Angeles Electrical Code
- w. NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)
- 2. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.
- 3. System installation and construction practices shall conform to standard industry practices as defined by the AV Installation Handbook (InfoComm, publisher), Sound System Engineering (Don and Carolyn Davis), Audio Systems Design and Installation (Philip Giddings, PE.)

1.03 SCOPE OF WORK

- A. This work includes completion of design and providing a new, complete mass notification system as described herein and on the contract drawings for the 24th Street Station and the Rental Car Center Station.
- B. The Contractor shall include in the Bid all labor, materials, tools, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, taxes and all necessary and related items required to provide complete and operational system shown and described in the Specification.
- C. The Contractor is responsible for providing and coordinating final equipment arrangements, locations, phased activities and construction methods that minimize disruption to station operations and provide complete and operational system.
- D. The Contractor shall coordinate with electrical contractor for provisions of horizontal conduit and field boxes required to accommodate cabling of all loudspeakers, microphones and other system equipment.
- E. The Contractor shall coordinate specialty electronic, Information Technology (IT) data networks and any other IT infrastructure system necessary for transport of audio or data information.
- F. Refer to Construction Drawings for device locations and details.
- G. The scope of work also includes training City of Phoenix personnel on the operation of the system, required maintenance tasks and frequencies, and the locations of all equipment necessary to maintain and operate the fire alarm system.



1.04 SUBMITTALS

- A. All submittals shall be in accordance with the general provisions of the Contract, including General and Supplementary conditions and other Division 1 Specification Sections.
 - 1. Consultant will not review partial submittals.
 - 2. Consultant will review up to two (2) submittals of any submittal topic.
 - 3. The cost of Consultant's time for additional submittal reviews due to non-conformance with the requirements listed herein will be borne completely by the Contractor.

- B. Pre-Award Submittal: The submittal must justify in the judgement of the Consultant, the Architect, and the Owner that the Bidder meets the requirements, that they have capability to perform the specified work for a project of this size and scope, and that they are capable of the necessary business and technical arrangements for this installation and the pursuant warranty service. The Owner reserves the right to evaluate and, if desired, waive certain of the below criteria and requirements if it is deemed to be in the best interest of the project. In all cases, the Contractor should submit all applicable criteria regarding their qualifications for evaluation. Submit the following as applicable:
 - 1. A detailed brochure describing its capabilities in terms of facilities, personnel, experience background, examples of similar installations, distribution arrangements with manufacturers and financial capability (including satisfaction of the project bonding requirements).
 - 2. Proof that contracting firm has at least five (5) years' experience in the fabrication, assembly, and installation of audiovisual system of similar magnitude and quality as specified herein.
 - 3. Information identifying all local agents and/or subcontractors assisting in the work.
 - 4. Identification of all sources of labor for all fabrication and installation throughout the duration of the project.
 - 5. Evidence of all necessary licenses and approvals to perform the specified work.
 - 6. Information on how, and by whom, it will fulfill the requirements of the warranty period.
 - 7. Information about two (2) representative projects, similar in scope to this project, completed within the past five (5) years. Include the Project Name, Project Locations, Owner's Name, Owner's Address, Owner's Phone, and a contact person employed by the Owners familiar with the Audiovisual system.
 - 8. Regarding equipment to be furnished, per Part 2, "Products" below:
 - a. Submit a statement of subcontractors, franchises, distributorship, dealerships, arrangements and agreements with manufacturers of equipment to be used for this work.



- b. Submit a complete bill of quantities, including all material, components, devices and equipment required for this work. The bill of quantities shall be tabulated respective of each and every system as specified, in the order of the specification section 2 below, and shall contain the following information for each item listed:
 - 1) Quantity.
 - 2) Description.
 - 3) Manufacturer's name.
 - 4) Manufacturer's model number.
 - c. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If an alternative listed is discontinued prior to installation, the Contractor shall submit a substitution request to provide the manufacturer's replacement model. The Consultant shall be the final judge of the acceptability of substitutions.
- 9. Credentials if its project engineer for review and approval. This person shall:
 - a. Either be a university graduate engineer in electrical or electronic engineering of physics and have at least five years' experience with similar electronic and optical specialty systems or have other experience and educational background appropriate for the Work as approved by the Consultant and the Owner.
 - b. Observe at all times a good working relation with the Architect's and Owner's representatives and cooperate with engineers and technicians assigned by the Owner, who are charged with the operation and maintenance of the system.
 - c. Provide all technical liaisons between the Contractor, the Architect, the Owner and the Consultant(s). This shall include participation in meetings and conferences. They will be required to be present at the project site for final inspection, approve the operating and maintenance manuals, and provide the specified instruction to designated members of the Owner's staff.
 - d. Be responsible for supervision of all technical work that is part of the contract. This supervision includes the following:
 - e. Preparation of all construction Drawings from information within the specifications and the Drawings, including approval and signing of all shop Drawings.
 - f. Supervision of shop fabrication and field installation work to assure conformance with the contract Drawings, the specifications, and the approved shop Drawings to assure workmanship of the highest quality. They shall oversee the testing of all assemblies and sub-assemblies prior to delivery to the project site.
 - g. Take a leading role in the specified testing of the completed installation to assure themselves for the Contractor that all specifications are met. Work with and assist the Consultant in their final testing for approval and acceptance of the system for the Owner.



10. Proof of the firm's current membership in (or at least two (2) supporting staff members in) two (2) or more of the following professional Audiovisual organizations for two (2) or more years:
 - a. NSCA: National Systems Contracting Association
 - b. ICIA: International Communications Industries Association
 - c. AES: Audio Engineering Society
 - d. USITT: United States Institute for Theatre Technology
 11. Credentials of supporting staff who have received current factory certifications from any/all equipment manufacturers whose franchise agreements require it and who meet the following qualifications:
 - a. The supervisor of the work of this section shall have at least five (5) years direct professional experience with devices, equipment, and system installation of the type and scope specified herein.
 - b. All personnel engaged in the installation of this Section shall have at least three (3) years direct experience with devices, equipment, and system installations of the type and scope specified herein.
 - c. In addition, submit proof of at least two (2) current staff member certifications in two (2) or more of the following:
 - 1) NICET-II (Certification by National Systems Contractor's Association)
 - 2) NICET-III (Certification by National Systems Contractor's Association)
 - 3) C-EST (Certification by National Systems Contractor's Association)
 - 4) R-ESI (Certification by National Systems Contractor's Association)
 - 5) CTS-D (Certification by International Communications Industries Association)
 - 6) CTS-I (Certification by International Communications Industries Association)
- C. Post Award Submittals: Submit within 30 days of award.
1. Submit four (4) copies and one (1) reproducible (CD-ROM [drawings as .dwg; documents as .pdf; software as per manufacturer's directions]) of the following:
 - a. A statement of subcontractors, franchises, distributorship, dealerships, arrangements and agreements with manufacturers of equipment to be used for this work.
 - b. Complete bill of quantities, including all material, components, devices and equipment required for this work. The bill of quantities shall be tabulated respective of each and every system as specified, in the order of the specification section 2 below, and shall contain the following information for each item listed:
 - 1) Quantity
 - 2) Description
 - 3) Manufacturer's name and model number
 - 4) Manufacturer's specification sheet



2. Schedule: Within thirty (30) calendar days of the receipt of the notice to proceed the Contractor shall prepare and submit for approval, in accordance with the General Conditions, a schedule which shall include, but is not limited to, the following:
 - a. Submission of shop drawings, samples and layouts for all items described herein.
 - b. Start and Completion date(s) for field installation work.
 - 1) Installation date(s) of all wires and cables in conduits and required cable trays.
 - 2) Date when fully-operational equipment racks will be fully tested and ready for Consultant's observation.
 - 3) Delivery date(s) of all systems and subsystems to the project site.
 - c. Start and Completion date(s) for shop fabrication work.
 - d. Date of submission of samples for approval by the Architect of all finishes/materials which will be visible to the public.
 - e. Programming of all remote control and Digital Signal Processing driven devices.
 - f. Completion dates(s) for the following tests:
 - 1) Performance tests on all individual system components as they are received from the manufacturer in the Contractor's shop.
 - 2) Performance tests on completed assemblies and subassemblies assemblies, including all racks in the Contractor's shop.
 - 3) Performance tests on the completed systems as a whole prior to shipment to the project site.
 - 4) General performance testing of systems at the project site.
 - g. Completion dates for the following Shop and Field Observations.
 - 1) Shop fabricated assembly and subassembly observation.
 - 2) Substantial Completion Observation at the project site.
 - 3) Final acceptance observation at the project site.
 - h. Submission date for operating, maintenance manuals, as-built drawings, documentation and closeout materials.
 - i. In the event the Contractor wishes to deviate from the schedule once it is established and approved, he may do so only receiving written approval from the General Contractor.
- D. Field and shop Drawing Submittal: Within sixty (60) calendar days of the receipt of notice to proceed the Contractor shall prepare and submit for approval, in accordance with the General Conditions, a schedule which shall include, but is not limited to the following:
 1. Submit four (4) half-size copies and one (1) CD-ROM copy of the following:
 - a. Corrected items from previous submittals. All resubmitted drawings shall be identified with clouded changes. Label each cloud with delta number and date of resubmittal.
 - b. Control panel Layouts: Developed drawings of all control system panel layouts.



- c. Functional Diagram: single-line block diagram showing interconnection of all components, receptacles, terminal blocks, controls, transformers and loudspeakers in addition to the active elements. Include terminal and cable numbers, all system and component labels. Show detailed system component information including but not limited to manufacturer's name, model number, any specialized part number option and all input and output connection information, for each piece of equipment. No drawing codes shall be permitted. Mount one (1) full-scale original or photograph (not blueprint) copy behind acrylic in the control booth for each system.
- d. Floor plans, at scale of Contract Documents, showing the locations throughout the project of all receptacles, conduits, wireways, trays, pull boxes, junction boxes, equipment racks equipment and other devices with appropriate designations and fill.
- e. Riser diagrams, showing all elevations, room numbers, conduit sizes, types and fills, box sizes and types, devices, equipment and rack designations.
- f. Equipment rack elevation drawings scaled ($1\text{'-}1/2" = 1\text{'-}0"$ or larger):
 - 1) Front Elevations: include equipment designation, manufacturer's name, model number, rack location and rack designation.
 - 2) Rear Elevations: include AC power wireways and route of wiring harnesses.
 - 3) Sections: include depth of all equipment components.
- g. Patch bay elevations, showing all patch bay appearances and designations.
- h. Samples for approval by the Architect of all finishes/materials that will be visible to the public including at least receptacles and controls with associated trim plate and each type of loudspeaker baffle and/or grille.
- i. Cable schedules and run sheets, associates with each equipment rack and/or any isolated piece of equipment or device, including cable designation, type, manufacturer and manufacturer's type number, wire color, device and terminal designation and device location, keyed to both the system block diagram and equipment rack elevation drawings.
- j. Contractor fabricated items, detailed drawings showing all components, devices and equipment, including dimensions, component values, terminal designations, types, locations, manufacturer's name and model number.
- k. Loudspeaker cluster and monitor loudspeaker supports stamped and signed by an engineer licensed in the project state. Include all loads, location of attachment to building structure, complete layout of all components, devices and equipment, including dimensions, methods of assembly, and connections to supporting construction, details of hardware, locations, manufacturer's name and model number. All design calculations, loads, etc. shall be shown.

- I. All drawings shall be clear and legible. The minimum text size for all drawings shall be 1/8" high. Permissible scales shall be: 1/8"=1', 1/4"=1', 3/8"=1', 1/2"=1', 1"=1', 1-1/2"=1', 3"=1', 6"=1', and full scale
 - m. A bound volume or volumes of comprehensive specifications for all material, devices, components and equipment selected for use in this section, whether modified or not, provided as required under "Post Award Submittals" above.
- E. Digital Signal Processor (DSP) System Submittal for Owner review.
 - 1. Prior to programming the Digital Signal Processing (DSP) system, the Contractor shall submit shop drawings per the project standards showing all screen layouts and control descriptions of all system functions to the Owner for review and comment prior to actual programming of the system. Shop drawings shall include screen layouts of the DSP software "Control Pages" for all "configuration presets" and "parameter presets". Submit all information in native file format and hard copy form to the Consultant for review and approval. The contractor shall incorporate all Consultant and Owner comments into the programming of the system.
 - 2. Prior to delivery of the systems to the job site, the Contractor shall demonstrate fully functioning systems in the Contractor's facilities that include the DSP system programming. This demonstration shall coincide with the Owner's Representatives observation of Completed Sub-Assemblies (Refer to Part 3 paragraph entitled "System Performance Tests"). The Owner will review and comment upon the remote-control programming, and the Contractor shall incorporate all Owner comments into the programming of the systems.
 - 3. After the installation of the AV systems has been deemed substantially complete, but prior to final acceptance of the system, the Owner shall have a review period of thirty (30) days to observe the operation of the DSP system. At the end of this review period, the Owner may request programming changes relating to the look and feel of the operation pages or the functionality of commands. The Contractor shall make these changes prior to acceptance of the systems.
- F. Shop Test Statement Submittals:
 - 1. Submit four hard copies and one electronic of the following prior to shipping fabricated equipment racks to the Project site:
 - 2. A bound volume, or volumes, of results of performance tests and adjustment data, including all test procedures specified in Part 3 paragraph entitled "System Performance Tests". Example Shop Test Statement submittal templates are available from the Consultant upon request.
 - a. Submit a written request for equipment rack observation certifying that equipment racks are completely assembled, tested and ready for inspection.



- b. Detailed interior and exterior photos of assembly supporting claim for readiness for inspection.

G. Final Submittals:

1. Four (4) half-size copies and one (1) electronic of each of the block diagrams, plans, risers, patch bay drawings, rack elevations, cable schedules and detail drawings. All reproducible drawings shall also be submitted in electronic format. Electronic drawing format shall be AutoCAD® Release 2014 or later. COPAD shall have the right and capability to manipulate all electronic file drawings and documentation.
 - a. One (1) complete set of Functional diagrams dry mounted to matte board and set under clear acrylic cover.
 - b. One (1) additional set of rack elevation drawings, each drawing mounted in the associated equipment rack with a protective plastic cover
2. No more than thirty (30) days after Acceptance Testing, submit three (3) copies of each of the following manuals prior to, and as a requirement of, Owner Acceptance of the work of this section:
 - a. Equipment operating instructions; complete, comprehensive instructions for the operations of all contractor-fabricated devices and equipment items provided as part of the work of this section.
 - b. Manufacturer's installation, operating and service information including schematic diagrams for each item of equipment furnished. Order the equipment manuals in the order of the specifications. Provide tabs between each equipment manual. Provide a detailed index at the front of each manual indicating specification reference number, manufacturer's trade name, model number and part description. Provide three (3) copies to the Owner after they have been reviewed and approved by the Consultant.
 - c. Printed material within contractor-fabricated equipment and systems operating manuals shall be bond paper copies, offset or letterpress printed. Drawings, charts and graphs shall be bond paper offset printed. The systems contractor-fabricated equipment instruction manuals shall be composed using a single, consistent visual format and writing style; text shall be derived from component equipment manufacturer's instruction manuals and may include reproductions of artwork and other materials.
3. Submit four (4) copies of each of the following schedules, lists, and data prior to, and as a requirement of, Owner Acceptance of the work of this section:
 - a. All source code for any contractor provided or programmed equipment on CD-ROM.
 - b. Final bill of quantities; complete bill of quantities all material as delivered, including a separate schedule of portable equipment.
 - c. Equipment schedule; complete, final schedules of equipment and devices provided in each room, by room number and name.



- d. Performance, test and adjustment data; comprehensive documentation of all performance verification and correction procedures and measurements, including raw and equalized house curves and equalizer settings.
 - e. Maintenance and spare parts schedules; a comprehensive tabulation of equipment, devices, miscellaneous parts and maintenance items, including manufacturer's name, address, model number, systems use and miscellaneous information.
 - 4. No more than thirty (30) days after Acceptance Testing, provide one (1) copy of the following:
 - a. Certificates; any and all licenses, certificates of operation and/or compliance as required.
 - b. The system will not be accepted until these documents are reviewed and approved by the Owner's Representative.
- H. Paging Zone Code Documents.
 - 1. Submit floor plans which use color coding and shading to indicate all of the individual loudspeaker zones and the codes that access each loudspeaker zone individually and each zone group. Laminated color copies and PDF format software copies shall be provided.
 - 2. Submit a list of all paging stations, their locations, and which buttons or codes access which zone groups. If the paging stations are of the 12-button type and require a user-access code, the document is to contain a list of the user types, a description of their level of access, and what the access code is. The user types (for instance: emergency, administrator, airline employee, etc.) and levels of access shall be determined by the Owner and submitted to the Contractor in a timely manner.
 - 3. The documents above are to be submitted to the Consultant for approval prior to the System Acceptance testing. The final version of this document shall be created after one month of regular system use and written approval from the Owner that paging station zone group assignment are satisfactory.
- I. Post changes and modifications to the Documents as they occur. Drawings will be updated electronically and submitted to COPAD in accordance with the schedule provided for this by COPAD. Do not wait until the end of the Project. Consultant will periodically review Project Record Documents to assure compliance with this requirement.
- J. At every quarter, submit Project Record Documents to Consultant for COPAD's records.
 - 1. Upon completion of the as-built drawings, the Design Consultant will review the as built work with the Contractor.
 - 2. If the as built work is not complete, the Contractor will be so advised and shall complete the work as required.



3. The Contractor shall at all times keep an up to date set of as-built documentation at the project work site and available for review if requested by the Owner, Architect or Consultant.

1.05 QUALITY ASSURANCE

- A. The Contractor's Quality Assurance Inspector shall conduct a visual inspection of all installations to verify that the installations are in accordance with the COPAD's and manufacturer's specifications. Records of the inspections signed and dated by the Quality Assurance Inspector shall be provided to the Design Consultant. The Design Consultant shall be notified by the Contractor of any inspection(s) and the Design Consultant may elect to participate in any inspection(s). All QC information shall be provided to COPAD for input into the CMMS (refer to paragraph 3.7).
- B. Unless otherwise stated, all electrical, electronic and optical equipment shall be a product of firms regularly engaged in the manufacture of electrical, electronic or optical equipment. The equipment shall be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are prohibited and should not be submitted for review. It shall be the Contractor's responsibility to provide the Consultant with information regarding discontinued products listed as alternatives in the specification. If an alternative listed is discontinued prior to installation, the Contractor shall submit a substitution request to provide the manufacturer's replacement model.
- C. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and shall be verified by observation. Only firms having 5 years' experience in all aspects of the fabrication and installation of similar systems shall be allowed to perform the work.
- D. All materials and products shall be new and of professional quality. Unless specifically stated in the drawings or specifications, no existing or pre-owned materials shall be installed.
- E. The work specified herein, and in each of the allied sections, shall be accomplished by a single Contractor experienced in the design, fabrication, installation, checkout and warranty contract management of systems such as those described in each section. This Contractor shall have complete responsibility for the systems described herein and shall be the single contract point for the Architect, the Consultant and/or the Owner with respect to all work specified herein.
- F. Contractor Qualifications:



1. The Contractor shall have a minimum of five (5) years' experience in the fabrication, assembly, and installation of audiovisual systems of similar magnitude and quality to that indicated for this project.
2. The Contractor shall possess a current Contractors license in the appropriate category(ies) in the project state at the time of bid.
3. The Contractor shall employ a qualified project engineer on its staff assigned to this project. (Refer to Part 1 paragraph 1.5.E "Post-Award Submittal" subparagraph 12 "credentials of project engineer...").
4. The Contractor shall have current membership in (or employ at least two (2) staff with individual memberships in) one (1) or more professional Audiovisual organizations for two (2) or more years. (Refer to Part 1 paragraph 1.5.E "Post-Award Submittal" subparagraph 11 "Proof of firm's current membership in...").
5. The Contractor shall employ qualified staff assigned to this project. (Refer to Part 1 paragraph 1.5.E "Post-Award Submittal" subparagraph 13 "credentials of supporting staff...").

1.06 DELIVERY, STORAGE, AND HANDLING

A .

1.07 WARRANTY

- A. Materials and workmanship shall meet or exceed industry standards and best practices and be fully guaranteed for a minimum of two (2) years from Final Acceptance.
 1. The Contractor shall use qualified service personnel to conduct all maintenance work. Service personnel must be local to the project jurisdiction to allow required response times to be met.
 2. The Contractor shall be responsible for and make good, without expense to COPAD, any and all defects arising during this warranty period that are due to imperfect materials, appliances, improper installation or poor workmanship.
- B. Submit a copy of all manufacturer warranty information.
- C. The Contractor shall, within the warranty period, schedule two visits annually to inspect and perform preventive maintenance on the system. The first visit shall be six months after the commencement of the warranty period. The last visit shall be just prior to the end of the warranty period. All work done must be submitted to COPAD in a written report describing the work, the amount of time taken, and all the individual's names who performed the work.
- D. The Contractor shall return 90 to 120 days after the system has been turned over to the Owner for additional programming, maintenance and system fine-tuning. Conduct interviews with the user group via telephone to acquire information needed to complete this task. Allow for one full day of



programming in your initial bid to complete. Provide a per hour programming fee that will be charged if additional programming is needed.

- E. The following items shall be furnished to the Owner by the Contractor for future maintenance and repair:
 - 1. Provide (2) spare amplifiers
 - 2. Provide (1) spare DSP card
 - 3. Provide (2) spare ambient noise sensors

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. It is the intention of these specifications to provide a complete and properly operating system. The major items of equipment shall be furnished in the quantity indicated by the system diagrams on the drawings or in the quantity as specified herein (see Equipment Schedules at the end of the specifications). However, any minor equipment item or hardware that may not be specifically shown on the drawings or specified herein but required for proper paging system operation or installation shall be provided by the Contractor.
- B. All equipment and material shall be new and suitable for continuous operation.
- C. In any case, where a specific specification has not been included herein or shown on the drawings for any item that is required, the Contractor shall furnish only the best quality equipment or material consistent with the quality of other specified equipment and material.
- D. Where the specifications list several manufacturers for a particular major item of equipment such as power amplifiers or loudspeakers, the Contractor shall supply all of that item of equipment from one manufacturer. This specification identifies the essential functional requirements of the automatic networked fire alarm system(s) for installation. The manufacturer's equipment (hardware and software) and system configuration shall comply with or exceed the functional intent of this specification.

2.02 SUBSTITUTIONS

- A. Where a specific piece of equipment has been discontinued and/or replaced by a new model, submission of the new model or a suitable item as applicable may be required for evaluation prior to acceptance.
- B. If substitute equipment is allowed by written consent, the Paging Systems Contractor shall be completely responsible for the use of such equipment, including suitability with the equalization process to be employed. The Paging Systems Contractor shall replace all such equipment with equipment listed by



type number in the specifications if there is any evidence of equipment instability or unsuitability.

- C. Costs of any required evaluation and testing of substitute equipment shall be paid by the Paging Systems Contractor.
- D. Any use of substitute equipment shall be at no extra cost to the project.
- E. Proposed substitute equipment shall be specifically noted in submittals as "substitution" with a footnote stating the reason for the substitution.
- F. Offerors proposing to furnish an "or equal" product must furnish all descriptive material necessary to demonstrate the acceptability of such product. The Acoustical Consultant shall be the sole determiner as to whether the proposed "or equal" product is suitable for use based upon review of the descriptive materials furnished.

2.03 AUDIO AMPLIFIERS AND SIGNAL PROCESSORS

- A. (AMP1) AMPLIFIER, 70V, 4CH, 300W
 - 1. Features
 - a. Network enabled monitoring and control
 - b. Digital audio input bus, 256 channel
 - c. Load monitoring
 - d. Error reporting
 - e. Pilot Tone (20kHz) monitoring
 - f. GPI/O ports
 - g. On-Board DSP
 - 2. Acceptable
 - a. Crown DCi 4/300N
 - b. Consultant approved equal.
- B. (AMPFO) FAIL-OVER SWITCH, AMPLIFIER, 8 CH
 - 1. Features
 - a. Network enabled
 - b. GPI/O enabled
 - 2. Acceptable
 - a. Crown CT8SHO
 - b. Consultant approved equal.
- C. (DSP) DIGITAL SIGNAL PROCESSOR
 - 1. Features
 - a. Four card slot core frame
 - b. Dante digital audio interface
 - c. GPI i/o (12x6)
 - 2. Acceptable
 - a. QSC Q-SYS Core 510i



- 1) Furnish High Performance mic/line modules as required
 - 2) Furnish AEC input modules as required
 - 3) Furnish additional I/O cards as necessary
- b. Consultant approved equal

2.04 AUDIO TRANSDUCERS

- A. (S1) LOUDSPEAKER, CEILING RECESSED, 8", 70V
1. Features
 - a. 8" LF and 1.4" HF drivers
 - b. UL-1480 and UL-2043 rated
 - c. Furnish separate pre-install back can and round grille
 2. Acceptable
 - a. QSC AD-C820R System
 - b. Consultant Approved equal
- B. (S2) LOUDSPEAKER, SURFACE, 6.5", 70V
1. Features
 - a. 6.5" driver
 - b. Weather resistance rated IP65
 - c. UL-1480 rated
 - d. Furnish U-bracket for install
 2. Acceptable
 - a. Tannoy AMS ICT LS
 - b. Consultant Approved equal
- C. (M1) Ambient Noise Analysis Sensor, Type 1
1. Features
 - a. Weather-resistant model for outdoor use
 - b. Hemispherical polar pattern
 - c. Line-level output
 2. Acceptable
 - a. AKG PZM11 LL WR
 - b. Consultant approved equal.
- D. (M2) Ambient Noise Sensor, Type 2
1. Features
 - a. Hemispherical polar pattern
 - b. Line-level output
 2. Acceptable
 - a. AKG PZM-10 LL
 - b. Consultant approved equal
- E. (AMPEOL) END OF LINE SENSOR
1. Features
 - a. Utilize 20kHz pilot tone to support error messages based on loudspeaker line conditions.



- b. Switchable impedance 5 or 10 Ohms
- 2. Acceptable
 - a. Crown EOL Box
 - b. Consultant approved equal.

2.05 NOT USED

2.06 NOT USED

2.07 DATA NETWORK DISTRIBUTION SYSTEM

A. (AVPC) CONTROL & MONITORING COMPUTER:

- 1. Features (minimum requirements):
 - a. Small form factor chassis (SFF) (11.8"w x 3.5"h x 12.9"d) with 235watt power supply
 - b. ATX motherboard with minimum 3.20 GHz Intel i5-4750 Quad Core, 8GB DDR3 1333MHz RAM,
 - c. AMD Radeon HD8570 1GB video card w/ dual output (DP + DVI)
 - d. CD-R/RW/DVD+/-RW drive
 - e. 2.5 inch,500GB (min.), Solid-State SSD Hybrid drive
 - f. Dual 10/100/1000 Base Ethernet NIC (motherboard + card slot)
 - g. Rack mounted Flat panel LCD-TFT video monitor (RKMON)
 - h. Rack mounted 104 key PS2 keyboard + mouse (RKKBD)
 - i. Windows 10 Professional operating system
 - j. Provide Middle Atlantic custom CPU rack kit.
 - k. Provide minimum 30-minute UPS backup for the CPU.
- 2. Acceptable:
 - a. Dell OptiPlex 9020 and ancillary components/options.
 - b. Consultant approved equal.

B. (RKMON) Monitor, 17" Rack Mount:

- 1. Features:
 - a. Rack mountable
 - b. Resolution: 1920x1080 TFT LCD
 - c. Inputs: VGA + HDMI w/Audio
 - d. OSD On-screen Display function
- 2. Acceptable:
 - a. Acnodes RMW 6170 Plus HDMI option

C. (RKKBD) Keyboard/Touchpad, Rack Mount:

- 1. Features:
 - a. Keyboard / Touchpad
 - b. Rack mountable, 1RU
 - c. Built in KVM
- 2. Acceptable: Acnodes RK1200T

D. (D-#) Data Patch Panel



1. Features:
 - a. Rack Mountable, 2RU
 - b. Category 6 Rated
 - c. 48 Port Configuration
 - d. Furnish (1) 24" patch cord per jack pair
 - e. Furnish wall mounted patchcord cable hangers for all patchcords
2. Acceptable
 - a. Leviton eXtreme 6+ QuickPort Patch Panel with one factory certified patch cable per two ports (AVC shall furnish patchbays in sufficient quantity to fulfill the functional intent of the drawings.)
 - b. Consultant approved equal

2.08 NOT USED

2.09 RACKS, WIRE, CONNECTORS AND MISCELLANEOUS HARDWARE

- A. Rack Panels:
 1. Blank Panels:
 - a. Features:
 - 1) 1/8" anodized brushed aluminum finish.
 - 2) 19" standard EIA width.
 - b. Acceptable: Lowell, Middle Atlantic or approved equal.
 - c. Quantity: As shown on drawings.
 2. Vent Panels:
 - a. Features:
 - 1) 16 Ga. perforated steel with black power coat finish.
 - 2) 60% minimum open area.
 - 3) 19" standard EIA width.
 - b. Acceptable: Lowell, Middle Atlantic or approved equal.
 - c. Quantity: As shown on drawings.
 3. Rack Kit(s):
 - a. Features:
 - 1) 1/6" anodized brushed aluminum finish.
 - 2) Custom manufactured for each piece of equipment.
 - 3) 19" standard EIA width.
 - b. Acceptable: Middle Atlantic or manufactures optional rack kit.
 - c. Quantity: 1 for each non-standard 19" EIA piece of equipment.
- B. (BAL/UBAL) Line Input Transformer +4dB output to -10dB input:
 1. Features:
 - a. Unbalances "Pro" to "Consumer IHF" Outputs.
 - b. Transformer isolation.
 - c. Passive device.
 2. Electrical Characteristics:
 - a. Bandwidth: -3dB at 0.25 Hz and 100 kHz.
 - b. Input impedance: 13 kOhm.
 - c. Common Mode Rejection: greater than 60dB.



- d. Insertion loss: 14dB
 3. Acceptable: Jensen ISO-MAX PC-2XR or approved equal.
 4. Quantity: 1 per unbalanced stereo input pair.
- C. (ISO-A) 1:1 Line Transformer:
1. Features:
 - a. 1:1 turn ratio.
 - b. Transformer isolation.
 - c. Passive device.
 2. Electrical Characteristics:
 - a. Bandwidth: -3dB at 0.25 Hz and 100 kHz.
 - b. Distortion: > 0.001% THD
 - c. Common Mode Rejection: greater than 60dB.
 - d. Insertion loss: less than 1.5 dB
 - e. Hum Rejection: greater than 60dB.
 3. Acceptable: Jensen ISO-MAX DM2-2XX or approved equal.
 4. Quantity: Use as required.
- D. Rack Power Conditioner:
1. Features:
 - a. Power line filters for spike and RFI control.
 - b. 20-amp power conditioning capacity.
 2. Acceptable: SurgeX SX1120-RT or approved equal.
 3. Quantity: Provide 1 per equipment rack provided.
- E. Audio Terminal Blocks:
1. Features:
 - a. All mic, line level and DC control cables interconnecting with an equipment rack shall connect to an audio terminal block, prior to exiting the rack or landing on a piece of equipment.
 - b. Rated for stranded 20 GA - 24 GA wire.
 2. Acceptable: WAGO Style modular terminal blocks (must be used in conjunction with cable end ferrules and mfg. recommended tooling).
- F. High-Level Audio Terminal Blocks:
1. All loudspeaker lines leaving an equipment rack shall be connected via barrier-type screw terminal blocks.
- G. Installed Wiring: (NOTE: Non-plenum versions listed, furnish plenum equivalents as required by Code.)
1. Loudspeaker lines in conduit: standard electrical wire, stranded copper, color-coded, THHN/THWN type.
 - a. CONDUIT HAS BEEN SIZED FOR THHN
 - b. High Z: AWG #14 unless otherwise noted
 2. Circuit Integrity in Conduit Cable (CIC):
 - a. ComTran VITALink 14AWG Solid FPLR-CI-LS
 - 1) Install from amplifier top first loudspeaker in run.



- 2) Follow mfg installation instructions.
 3. Mic and Line, twisted, shielded pair #22: equal to Belden 8761 or WestPenn/CDT (x)454 or consultant approved equal.
 4. DC Control Lines:
 - a. low current loads (<2A) (mute, relays, VCA, LED): AWG #20.
 - b. medium current loads (>2A) (actuators, illuminators): AWG #18.
 - c. Acceptable: Carol 1130, West Penn 271, or approved equal.
 5. Unshielded, Twisted Pair:
 - a. Category 6
 - 1) Acceptable: Berk-Tek LanMark-1000, or approved equal.
- H. Connectors and Receptacles:
1. Only metal connector shells and bodies are permitted.
 2. Mic and Line:
 - a. Solder only. No IDC, 1-piece compression or screw terminal versions permitted.
 - b. Input: 3-pin female XLR-type and 1/4" TRS jacks where shown on drawings. Insulate 1/4" jacks from plate, do not ground pin 1 on XLRs.
 - c. Output: 3-pin male XLR-type and 1/4" TRS as above.
 - d. RCA: Only solder style, metal connector shells and bodies are permitted., no "molded assemblies" shall be permitted
 3. Loudspeaker:
 - a. Only Neutrik Speakon® devices are acceptable.
 - b. Wire all terminals unless otherwise noted.
 - c. Panel: Neutrik NL4MP or NL2MP as required.
 - d. Cords: NL4FC.
 - e. Cable couplers: Neutrik NL4MM.
 - f. Wooden box mounting: Neutrik NL4MPR.
 - g. All NL4 devices shall be cabled for two channel operation unless otherwise noted.
 4. Control: submit cut sheets.
 5. Production Communications: 3-pin and 6-pin male XLR-type as shown on drawings
 6. Digital Media (RJ45 style):
 - a. Only punch down style (female jack) connectors shall be acceptable.
 - b. No feed-thru's will be allowed.
 - c. Any male (plug) terminations shall be factory performed and certified.
- I. Receptacle Panels, aluminum:
1. Field-verify panel sizes required for backboxes.
 - a. Oversize flush panels sufficient to trim wall openings but not less than 1/2"
 - b. Size surface mount panels exactly to backbox yielding no sharp corners and chamfering edges



2. Aluminum panels 0.125" thick, with labels engraved and back-filled in black
 3. Anodized, horizontal brushed finish
 4. Submit engraved sample for approval by architects.
- J. DC Power Supplies:
1. Voltage and capacity as required with 100% headroom, UL (or other) listed: Acopian linear or approved equal, submit cut sheets.
 2. Provide and install in shielded metal chassis with fused LED status indicators.
- K. UPS Uninterruptible Power Supply
1. Acceptable: Middle Atlantic UPS-2200R-8IP
 - a. Rack mounted, furnish one, appropriately sized, unit per each rack populated with the following devices:
 - 1) RC's
 - 2) DSP's
 - 3) Digital Media Switches
 - b. Unit shall function as
 - 1) Conditioner
 - 2) UPS backup in case of brown-outs
 - 3) IP management of RC and DSP devices
 - 4) Soft shutdown in event of power loss
 2. Consultant Approved Equal

PART 3 EXECUTION

3.01 GENERAL

- A. System installation and construction methods shall conform to COPAD requirements, requirements of the State of Arizona and all applicable building codes.
- B. Contractor shall install equipment to meet any Seismic Zone requirements of the State of Arizona and as stated herein.
1. Where undefined by codes and standards, Contractor shall apply a safety factor of at least 2 times the rated load to all fastenings and supports of system components.
- C. All equipment locations shall be coordinated with other trades and field conditions before installation. Coordinate with all the Telecommunications, Mechanical and Electrical Drawings. Verify with Design Consultant the exact location and mounting height of all equipment in finished areas.
- D. All work shall be concealed above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, Engineer shall be notified before starting that part of the work. In areas with no



ceilings, install only after Design Consultant reviews and comments on arrangement and appearance.

- E. The Contractor shall patch all openings remaining around and inside all conduit, sleeves and cable penetrations to maintain the integrity of any fire rated wall, ceiling, floor, etc. The fire stop system shall consist of a dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.
- F. Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support work. Supports shall meet the approval of Design Consultant.
- G. Cable Dressing: Where fiber or copper cables enter telecommunications room, it shall be neatly bundled and fastened and a suitable transition device installed to minimize tension and bend radius on cables. All cable runs shall be horizontal or vertical, and bends shall comply with minimum specified cable bending radii.
 - 1. Cables shall be combed, and each strand shall run parallel with the other strands.
 - 2. After combing and straightening strands, Contractor shall separate strands into bundles according to routing requirements and termination points.
 - 3. Bundles shall be secured with hook-and-loop cable strap material.
 - a. Cable ties manufactured from a hard polymer material, such as plastic or nylon, shall not be used.
 - b. Hook-and-loop material shall be low life cycle, back-to-back type, black in color, and ½ inch wide.
 - 4. Contractor shall begin to bundle and strap cables within 6 inches of exit from conduit, and bundles shall have cable straps applied at intervals not greater than 10 feet for entire length of vertical and horizontal run.

3.02 PHASES OF IMPLEMENTATION

- A. Provide a consolidated and integrated schedule.
- B. Functionality of the existing paging system shall be maintained at all times. The work shall be done in such a fashion that no existing paging zone is out of service during the hours of 5:00am to Midnight, and no zone is out of service at all for more than 1 hour in areas which are still in use. Temporary paging must be provided as required at no additional cost to the Owner.

3.03 INSPECTIONS



- A. The Contractor shall perform a detailed inspection of the site prior to submitting any technical data for approval.
- B. The Contractor shall verify that the proposed equipment and methods of installation are compatible with the existing conditions and prepare a corresponding written report of their findings.
- C. COPAD shall be notified in writing if modifications of the existing building are required in order to accommodate the new equipment. These modifications shall be made only upon receiving written approval from COPAD.
- D. Submit installation drawings for COPAD review and approval.

3.04 TESTING REQUIREMENTS

- A. Phases of Testing
 - 1. On-Site Performance Verification Testing
 - 2. On-Site Endurance Testing
- B. Test Plan/Procedure: The Contractor shall submit a Test Plan for each testing phase for the review and approval of the Design Consultant. The test plan for each phase shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The test plan shall be provided at least thirty (30) days prior to the scheduled start of each test. Test plans shall contain at a minimum:
 - 1. Functional procedures including use of any test equipment
 - 2. Test equipment is to be identified by manufacturer, model and last calibration date.
 - 3. Interconnection of test equipment and steps of operation shall be defined
 - 4. Expected results required to comply with specifications
 - 5. Record of test results with witness initials or signature and date performed
 - 6. Pass or fail evaluation with comments.
 - 7. The test procedures shall provide conformity to all specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.
 - 8. Documentation verification, both interconnects and functionality, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.
 - 9. The Contractor shall cooperate with and provide COPAD representative(s) the opportunity(s) to participate in any of the tests.
 - 10. Test Reports: The Contractor shall submit for each test, a test report document that shall certify successful completion of that test. Submit for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:
 - a. Commentary on test results.



- b. A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution.
 - c. Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test.
 - d. Signatures of persons who performed and witnessed the test.
 - e. Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to the Owner. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Design Consultant, before any subsequent testing phase is performed.
- C. Performance Verification Testing
 - 1. Complete operational testing of all components and systems shall be witnessed by the Design Consultant and designated COPAD Representatives.
 - 2. Schedule test with Design Consultant. Do not begin testing until:
 - a. All systems have been installed and individually and jointly tested to ensure they are operating properly.
 - b. Written permission from Design Consultant has been received.
 - 3. Testing: As part of performance verification, test all components of system. The tests shall demonstrate system features.
 - 4. Verification: Verify correct operation of the required system functionality as defined in these specifications.
 - 5. Adjustment, Correction, and Completion:
 - a. Correct deficiencies and retest affected components.
 - b. Make necessary adjustments and modification to system after obtaining approval of the Design Consultant.
 - c. Completion: Performance verification test shall be complete when testing or retesting of each component has produced a positive result and has been approved in writing by the Design Consultant.
 - 6. Recording:
 - a. Describe actual operational tests performed and equipment used and list personnel performing tests.
 - b. Record in tabular form all test results, deficiencies, and corrective measures.
 - 7. Termination
 - a. Performance verification test shall be terminated by the Design Consultant when:
 - 1) Individual components, subsystems, or the integrated system fail to perform as specified.
 - 2) It is determined that system is missing components or installation is not complete.



- a) Upon termination, corrective work shall be performed and performance verification test rescheduled with the Design Consultant.
 - b) Retesting shall be performed by Contractor at no additional expense.
 - c) Contractor shall continue to perform corrective actions and retest until system passes all tests to satisfaction of the Design Consultant.
- D. Endurance Testing
- 1. Provide personnel to monitor the systems 24 hours per day, including weekends and holidays during endurance testing. This monitoring may be remote provided the system can issue Email/SMS error reports.
 - 2. Start test after:
 - a. Successful completion of performance verification testing.
 - b. Training as specified has been completed.
 - c. Correction of deficiencies has been completed.
 - d. Receipt of written start notification from the Design Consultant.
 - 3. Monitor all systems during endurance testing. Coordinate monitoring with the Design Consultant.
 - 4. Recording: Record data on approved forms to provide a continuous log of systems performance. Include:
 - a. Date and time for all entries.
 - b. Name of individual making entry.
 - c. Environmental conditions.
 - d. Authority activities in process.
 - e. Description of all alarm annunciations, responses, corrective actions, and causes of alarms. Classify as to type of alarm.
 - f. Description of all equipment failures, including software errors.
 - g. Description of all maintenance and adjustment operations performed on system.
 - h. Daily and weekly tabulations.
 - i. Daily entries of performance data shall be reviewed by the Design Consultant's representative designated to observe monitoring of system.
 - 5. The Design Consultant may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Phase II.
 - 6. Testing
 - a. Phase I - Initial Testing:
 - 1) Time: 24 hours per day for 7 consecutive calendar days.
 - 2) Make no repairs during this phase unless authorized in writing by the Design Consultant.
 - 3) If system experiences no failures, proceed to Phase II - Initial Assessment.



- b. Phase II - Initial Assessment:
 - 1) After conclusion of Phase I or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing.
 - 2) After submission of report, schedule review meeting at job site. Schedule date and time with the Design Consultant.
 - 3) At review meeting, demonstrate that all failures have been corrected by performing verification tests.
 - 4) Based on report and review meeting, the Design Consultant will direct Contractor to repeat Phase I, restart Phase I, or proceed to Phase III - Final Testing.
- c. Phase III - Final Testing:
 - 1) Time: 24 hours per day for 7 consecutive calendar days.
 - 2) Make no repairs during this phase unless authorized in writing by the Design Consultant.
- d. Phase IV - Final Assessment:
 - 1) After conclusion of Phase III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing.
 - 2) After submission of report schedule review meeting at job site. Schedule date and time with the Design Consultant.
 - 3) At review meeting, demonstrate that all failures have been corrected by performing verification tests.
 - 4) Based on report and review meeting, the Design Consultant will approve endurance test or direct Contractor to repeat all or part of Phases III and IV.
- 7. Adjustment, Correction, and Maintenance
 - a. During endurance testing make adjustments and corrections to system only after obtaining written approval of the Design Consultant.
 - b. During endurance testing, perform required maintenance on systems including provision of replacement parts.
- E. Commissioning Testing
 - 1. The Contractor shall develop a commissioning test plan that includes the following components, as a minimum:
 - a. COPAD readiness
 - b. Operational procedures verification
 - c. Disaster recovery procedures
 - d. Computerized Maintenance Management System data verification
 - e. Change management procedures
 - 2. The commissioning test plan/procedures shall be submitted to the Design Consultant for review and approval.



F. Final Inspection and Acceptance

1. After endurance testing is complete, review tabulated records with the Design Consultant.
2. The Contractor will not be responsible for failures caused by:
 - a. Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished, and automatic shutdowns and restarts of systems performed as specified.
 - b. Failure of any COPAD furnished power, communications, and control circuits provided failure was not due to Contractor furnished equipment, installation, or software.
 - c. Failure of existing COPAD equipment provided failure was not due to Contractor furnished equipment, installation, or software.
3. When performance of integrated system does not fall within the above rates, determine cause of deficiencies, correct, and retest.
4. When requested by the Design Consultant, extend monitoring period for a time as designated by the Design Consultant.
5. Period shall not exceed 60 days exclusive of retesting periods caused by termination of Phases I or III and assessment period of Phases II and IV.
6. Submit final report of endurance testing containing all recorded data.

3.05 SYSTEM STARTUP

- A. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Testing. Perform at least the following procedures:
- B. Mechanical. Verify:
 1. Integrity of all support provisions.
 2. Absence of debris of any kind, tools, etc.
- C. Power and Isolated Ground. Verify:
 1. Isolation of Isolated Ground system from raceway and related ground.
 2. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
 3. Proper provision of power to devices and equipment.
- D. Signal Wiring. Verify:
 1. Integrity of all insulation, shield terminations and connections.
 2. Integrity of soldered connections. Absence of solder splatter, solder bridges.
 3. Routing and dressing of wire and cable.



4. Continuity, including conformance with wire designations on running sheets, field and shop drawings.
 5. Absence of ground faults.
 6. Polarity.
- E. Use the proper sequence of energizing systems to minimize the risk of damage.
- F. Sound Systems:
1. Electronic Tests; confirm:
 - a. Gain at 1 kHz.
 - b. Maximum output.
 - c. Input clipping level.
 - d. Frequency response.
 - e. Total harmonic distortion.
 - f. Signal-to-Noise ratio.
 - g. Signal-to-Crosstalk ratio.
 2. Gain control settings: Establish tentative normal settings for all gain controls. Set all equalizers flat. Set all automatic gain control devices to bypass. Terminate power amplifier outputs with power load resistors with resistance value within 10% the nominal output impedance of the respective amplifier. Adjust all gain controls on equipment for optimum signal to noise ratio and signal balance and, unless they are sub panel mounted, cap them to prevent tampering. Unless specified or directed otherwise, adjust gains such that in a given system the "front end" operates at unity gain and maintains 10 dB of clip margin referenced to the first onset of clipping of the associated power amplifier(s). Measure and document system gains at 1 kHz. Settings may require further adjustment by the Contractor, a result of testing by the representative of the Owner.
 3. Freedom from parasitic oscillation and radio frequency pickup: Maintain previous setup. Set up for each mode of operation specified in the functional requirements; verify that all systems are free from spurious oscillation and radio frequency pickup using broadband oscilloscope. Correct any such defects.
 4. Hum and noise level/signal to noise level/signal to crosstalk level: Maintain previous setup. Terminate microphone and line level inputs with shielded resistors of 150 and 600 ohms, respectively. Set available variable gain controls such that full power amplifier output would be achieved with 40 dBm input level at a microphone input and
 5. +12 dBm at a line level input. Measure and document the specified parameters of the system overall for each microphone input channel and line level input channel. Compare with nominal signal level.
 6. Total Harmonic Distortion: Maintain previous setup. Measure at reference operating level at 63 Hz, 125 Hz, 1 kHz, 10 kHz.

G. Electro/Acoustic Tests:



1. Uniformity of coverage.
2. Electronic and acoustic frequency response/one third octave equalization. Measure at ear level. Comply with applicable portions of NFPA 72-2016 Representative of the Owner will direct final adjustment.
3. Maximum continuous sound pressure level (in the reverberant field). Drive systems with broadband pink noise. Sustain for at least five minutes with no system damage. Measure for "A" and "C" weightings at ear level on loudspeaker axis. Turn off noise.
4. Acoustic signal to noise ratio referenced to the specified maximum continuous sound pressure level in the reverberant field. Measure for "A" and "C" weightings at ear level on loudspeaker axis with mechanical systems operating. Present comparison with previous measurement.
5. Acoustic gain before feedback. Locate acoustic source (4-inch loudspeaker/pink noise generator) two feet from system microphone. Measure at system microphone position and at most distant listener position at ear level. Present comparison.

H. System Overall:

1. Verify levels.
2. Provide permanent "wedge" type labels on all controls, as applies, to indicate correct settings after systems performance testing and adjustment procedures have been successfully completed.

I. At least 10% of the total number of zones must be tested at two different times and at two different locations within the zone during peak hours and during quiet hours. These tests must indicate that pages are at least 6dB, but no greater than 10dB above, ambient noise levels. Measured ambient noise levels must be time averaged over a period of at least one minute and are not to include announcements from the paging system.

J. Upon completion of the installation of all loudspeakers in an area, perform the following tests and record results. Correct non-conforming conditions, unless the cause is clearly outside the Work of this Section, in which case submit the apparent cause to the Owner.

1. Loudspeaker Line Impedance: At terminal cabinets at equipment rooms, measure the impedance of each loudspeaker line. Sweep from at least 20 Hz to at least 16 kHz.
2. Loudspeaker Polarity: Test the acoustic polarity of all loudspeakers using an Acoustic Polarity Tester.
3. Freedom from Buzzes, Rattles and Objectionable Distortion: Individually apply to each loudspeaker line a slow sine wave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles and objectionable distortion.
4. Uniformity of Coverage: Apply broadband Pink Noise. Adjust level to approximately 70-80 dBA at measurement locations. Measure in 4 kHz octave band at ear level. Adjust loudspeaker aiming and 70 Volt loudspeaker taps for uniformity of coverage.



- K. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage resulting from Contractor work/equipment.

3.06 IDENTIFICATION AND LABELING

- A. All cables and patch cables shall have a permanent label attached at both ends.
- B. The Contractor shall confirm specific labeling requirements with the Design Consultant prior to cable installation or termination.
- C. All indoor cable and patch cable labels shall be pre-printed using BRADY TLS 2200 printer or equivalent and shall be placed loose on the patch cable near the connector end without heat shrinking labels. Labels shall use a three line format with the origination patch panel and port on the first line, the destination patch panel and port on the second line and the system or other descriptive information on the third line.

3.07 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM

- A. As required by COPAD, Information regarding all equipment including model, nomenclature, serial number, function, location, recommended preventative maintenance schedule, Quality Assurance Inspections and other pertinent data may be stored in a CMMS database. Contractor shall include in their Bid the cost for collecting and inputting this data for all systems and equipment provided by this Contract into this database.

3.08 TRAINING

- A. By means of training classes augmented by individual instruction as necessary, the Contractor shall fully instruct COPAD's designated staff and Airline personnel in the operation, adjustment and maintenance of all products, equipment and systems.
- B. The Contractor shall be required to provide all training aids, e.g., notebooks, manuals.
- C. The Contractor shall provide an appropriate training area equipped with all required equipment. The location of the training area shall be coordinated with the Design Consultant.
- D. All training shall be completed a minimum of two weeks prior to system cut over. Training schedule shall be subject to the Design Consultant's approval.
- E. Training shall be conducted by experienced personnel and supported by training aids. An adequate number and amount of training material shall be provided by the Contractor. The following is considered a minimum.



1. Functional flow-charts, overall block diagrams, and descriptive material for all software;
 2. Schematic drawings for each of the hardware components;
 3. All procedure manuals, specification manuals, and operating manuals;
 4. As-built drawings.
- F. Participants shall receive individual copies of technical manuals and pertinent documentation at the time the course is conducted. The courses shall be scheduled such that COPAD personnel can participate in all courses (no overlap).

3.09 TYPES OF TRAINING

- A. User Training: System users shall be instructed in all aspects of operations of the system. Four (4) hours of basic user training shall be provided. Additionally, four (4) hours of advanced user training shall be provided.
- B. Technician Training: Eight (8) hours of maintenance training shall be provided. Training for maintenance technicians shall be provided on site, and shall include, but not be limited to, installation, operation, renovation, alteration, inspection, maintenance and service on each system and subsystem provided, so as to enable troubleshooting and repair to the component level.
- C. System Administrator Training: System Administrator Training shall be provided. System Administrator Training shall include both classroom work and on the job training and shall be provided on-site at PHX or at a location within 50 miles of PHX.
1. Classroom Training: Up to eight (8) hours of software training shall be provided for each system. The Contractor shall structure the course to describe all systems, software and applications and support programs. This course shall include a functional overview of the complete software system. The course material must be presented in depth with the instructor covering detailed design, structure, and algorithms.

3.10 FINAL INSPECTION AND ACCEPTANCE

- A. Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation including data input of all installed cables in the COPAD management system and successful performance of the cabling system for a two-week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, COPAD shall be provided with a numbered certificate from the Manufacturer registering the installation.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	03/21/2018	N/A	All	First Edition



SECTION 13922

ELECTRIC DRIVEN, CENTRIFUGAL FIRE PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for new electric driven, centrifugal fire pumps.
- B. Products Installed But Not Supplied Under This Section:
 - 1. New fire alarm control unit for the 44th Street Sky Train Station.
 - 2. Addressable monitor modules for the fire sprinkler system tamper and flow switches and fire pump signals.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 03100 - Concrete Forms and Accessories.
 - 6. Section 03200 - Concrete Reinforcement.
 - 7. Section 03300 - Cast-In-Place Concrete.
 - 8. Section 13851 - Fire Alarm.
 - 9. Section 15060 – Hangars and Supports.
 - 10. Section 15070 – Mechanical Sound, Vibration, and Seismic Control.
 - 11. Section 15995 - Commissioning of Mechanical Systems.
 - 12. Section 16061 - Electrical Grounding and Bonding.
 - 13. Section 16120 – Conductors and Cables.
 - 14. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. FACU: Fire alarm control unit.
 - 2. LED: Light emitting diode.
 - 3. MSDS: Material safety data sheets.
 - 4. N/C: Normally closed.
 - 5. NICET: National Institute for Certification in Engineering Technology.
 - 6. N/O: Normally open.
 - 7. NRTL: Nationally Recognized Testing Laboratory.
 - 8. RMS: Root-mean-square.



9. USB: Universal serial bus.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
3. Corrosion Resistance Ratio (CRR): An Underwriters Laboratory, Inc. term for the estimated life expectancy of a pipe joint based on the calculated wall thickness at the base of the first exposed thread, assumed to be the weakest point of the pipe length.
4. Unifier: The web based management software/database system the Phoenix Sky Harbor International Airport (PSHIA) uses to manage all correspondence, requests for interpretation (RFI), submittals, and similar information related to construction activities for the PHX Sky Train Project.

C. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
 - a. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASTM International (ASTM):
 - a. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. Phoenix Fire Code and Amendments.
 - c. Annual Facilities Permit Program Registration Packet.
4. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. ICC International Fire Code as Amended by the City of Phoenix.
6. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1 – Motors and Generators.



- b. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- 7. National Fire Protection Association (NFPA):
 - a. NFPA 13 - Standard for the Installation of Sprinkler Systems.
 - b. NFPA 14 - Standard for Installation of Standpipe and Hose Systems.
 - c. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection.
 - d. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
 - e. NFPA 70 - National Electrical Code® (NEC).
 - f. NFPA 72 – National Fire Alarm and Signaling Code.
 - g. NFPA 1963 – Fire Hose Connections.
- 8. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - a. Fire Protection Engineering Technology Automatic Sprinkler System Layout Program Detail Manual.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. UL 218 - Standard for Fire Pump Controllers.
 - b. UL 393 - Standard for Indicating Pressure Gauges for Fire-Protection Service.
 - c. UL 448 - Standard for Centrifugal Stationary Pumps for Fire-Protection Service.
 - d. UL 508 - Standard for Industrial Control Equipment.
 - e. UL 668 - Standard for Hose Valves for Fire-Protection Service.
 - f. UL 1478 - Standard for Fire Pump Relief Valves.
 - g. UL 1726 - Standard for Automatic Drain Valves for Standpipe Systems.
 - h. UL Fire Protection Equipment Directory (FPED).
 - i. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.
- 10. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Prior to commencement and after completion of the Work of this Section, submit written notification to the Program/Project Manager.
- 2. Coordinate with the Program/Project Manager, the Commissioning Authority (CA), the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the



Commissioning Authority (CA), the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

3. Coordinate the installation and testing of the electric driven, centrifugal fire pumps and the associated equipment and circuits with the appropriate Subcontractors, equipment maintenance and testing representatives, the Sky Harbor International Airport Aviation Department, and the Authorities Having Jurisdiction.
 - a. Coordinate the connection of the monitor modules for pump running, power loss, phase reversal, and the transfer switch for the emergency power system.
 - b. Coordinate the location of the fire pump test header with the drainage shown on the Contract Drawings.
 - c. Coordinate the underground fire line with the foundation notching shown on the Contract Drawings.
 - d. Coordinate the relief valve discharge so that water is routed to an appropriate drain shown on the Contract Drawings.
 - e. Coordinate the Pre-Acceptance and the Final Acceptance Test of the electric fire pump specified in this Section with the Program/Project Manager, the Sky Harbor International Airport Aviation Department, the Commissioning Authority (CA), and other Authorities Having Jurisdiction (AHJ).
 - 1) Furnish all participants with at least 5 working days advance notice prior to all tests.
 - 2) At the time of notification, submit 1 copy of the approved Record Sets of Drawings for the electric driven, centrifugal fire pump system and the approved Electric Driven, Centrifugal Fire Pump System Test Plan to the Program/Project Manager.
 - f. Final Acceptance Test:
 - 1) In order to assure attendance at the Final Acceptance Test by the necessary representatives, provide reasonable notification of the test date to each representative scheduled to witness the test at least 48 hours prior to the test.
 - 2) Do not conduct this test until all parties agree on a test date.
4. Coordinate the dates and times of each required training session as specified herein through the Sky Harbor International Airport Aviation Department, not less than 2 weeks prior to the training session.

B. Sequencing:

1. Complete installation of the fire suppression system components, including the fire pumps, so the fire alarm equipment Supplier can make



the final connections and conduct tests of the fire alarm system as specified in Section 13851, Fire Alarm, without delaying the Work.

C. Scheduling:

1. Prior to beginning the Work of this Section, submit a schedule indicating the fire pump system installation sequence and time frame to the Program/Project Manager for approval.
 - a. Include specific time lines indicating the start and completion of major portions of the fire alarm system installation.
 - b. Include time lines indicating the start and completion of impairments of the existing fire sprinkler system.
 - c. Indicate the delivery dates of the equipment to be supplied.
 - d. Indicate the dates for the Fire Sprinkler System Pre-Acceptance and the Final Acceptance Tests.
2. Submit weekly schedule updates to the Program/Project Manager for approval.
3. Advise the Program/Project Manager of all anticipated projects the Contractor and the equipment Supplier may have with the same approximate completion date as this Contract, and what impact those projects may have on the timely completion of this Contract.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Fire pumps, equipment, and system components.
 - 2) Preliminary equipment list for the fire pump system.
 - 3) Sequence of operation for the electric drive, centrifugal fire pump system.
 - b. Shop Drawings:
 - 1) Fire pump system.
 - 2) Working Drawings for installation of the fire pump system.
 - c. Delegated Design Submittals:
 - 1) Fire pump systems' hydraulic calculations.
 - d. Special Procedure Submittals:
 - 1) Written notification of the commencement of the Work of this Section.
 - 2) Schedule indicating the fire pump system installation sequence and time frame, and weekly schedule updates.
 - 3) Fire Pump Supplier's Compliance Plan.



- 4) Electric Driven, Centrifugal Fire Pump System Test Plan.
- 5) Written notification of the completion of the Work of this Section.
- e. Qualification Statements:
 - 1) Qualifications of the fire pump system installer.
 - 2) Qualifications of the Contractor's project manager and the fire pump system Supplier's technical representative in responsible charge of installation.
 - 3) Qualifications of the proposed fire pump system Supplier's technical representative responsible for preparing the fire alarm system Shop Drawings and calculations.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Flow meter system manufacturer's written installation instructions.
 - 2) Grease-lubrication-type bearing manufacturer's written lubrication instructions.
 - b. Site Quality Control Submittals:
 - 1) Factory-authorized service representative's inspection and testing reports.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Firm fixed price to furnish an Electrically Driven, Centrifugal Fire Pump System Maintenance Contract.
 - b. Operation and Maintenance Data:
 - 1) A copy of NFPA 20.
 - 2) A copy of NFPA 25.
 - 3) Suggested spare parts list and the firm guaranteed unit prices for all of the maintenance materials.
 - c. Warranty Documentation:
 - 1) New Electrically Driven Fire Pump Materials Warranty.
 - 2) New Electrically Driven Fire Pump Workmanship Warranty.
 - d. Record Documentation:
 - 1) Record Sets of Drawings for the electric driven, centrifugal fire pump system.



1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:

- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.

2. Authorities Having Jurisdiction:

- a. To obtain approval of the fire alarm system by the Program/Project Manager, the City of Phoenix Fire Department, Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction, documents prepared according to the requirements specified in NFPA 13 and the City of Phoenix Annual Facilities Permit Program Registration Packet, including Shop Drawings, water flow test results, and material specifications, are required.
 - 1) Submit these documents and the required fees to the Annual Facilities Permit Program, attention Mary Schilling, for review and approval.
 - 2) Submit the fire protection system Permit received to the Program/Project Manager.

B. Qualifications:

1. Fire Pump System Installer's Qualifications:

- a. Employ a firm that is licensed in the State of Arizona, and that has a minimum of 5 years of documented experience installing fire sprinkler and standpipe systems and fire pumps similar in type to that required for this Contract.
- b. Employ a firm that has installed fire sprinkler and standpipe systems, and fire pumps similar in scope to this Contract, and that has obtained design and inspection approvals for similar projects from the Authorities Having Jurisdiction.
- c. Submit the qualifications of the proposed fire pump system installer and the resume of the proposed system installer's foreman and project manager-assigned to this Contract to the Program/Project Manager for approval.



- 1) Include the number of years the proposed fire pump system installer has been in business, and their service policies, warranty definitions, and prior experience with installations that include the type of equipment that is to be supplied under this Contract.
 - a) Furnish a list of at least 3 installations similar in scope to this Contract, including the addresses of the properties, contact names, telephone numbers, and the types of system equipment installed.
- 2) Include proposed system installer's personnel and company contact information.
 - a) Furnish sufficient information to describe the qualifications of the proposed representatives, the work efforts to be performed, and the materials to be provided, and include the names and qualifications of the Contractor's project manager who will be in responsible charge during installation of the fire alarm system.
- d. Nonconformance of the proposed fire pump system installer's qualifications with the qualifications specified in this Section are cause for immediate elimination of the proposed system installer without further comment.
- e. Do not replace an approved fire pump system installer or the approved fire pump system installer's foreman without the written approval of the Program/Project Manager.
 - 1) No requested change in Subcontractor will be accepted unless justification is made in writing to the Program/Project Manager and approved.
 - a) Upon written request, the Program/Project Manager may authorize changes, but the decision to do so is at the sole choice and discretion of the Program/Project Manager.
2. Fire Pump System Supplier's Technical Representatives' Qualifications:
 - a. To supervise the field installation of the fire pump system provided under this Contract, employ a trained and qualified technical representative who, at a minimum, holds a current NICET Level II Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification.
 - b. Submit the name and qualifications of the proposed fire pump system Supplier's technical representative who will be in responsible charge of the installation of the system under this Contract to the Program/Project Manager for approval.
 - c. Do not replace an approved fire pump system technical representative without the written approval of the Program/Project Manager.



- d. The specified fire pump system Shop Drawings and calculations must be prepared by a certified technician holding at a minimum NICET Level III Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification.
 - 1) Submit the name and qualifications of the proposed fire pump system Supplier's technical representative who will be responsible for preparing the fire alarm system Shop Drawings and calculations under this Contract to the Program/Project Manager for approval.
 - a) Furnish sufficient information to describe the qualifications of the proposed representative, the work efforts to be performed, and the materials to be provided.

C. Certifications:

- 1. Listing and Labeling of Components, Devices, and Accessories:
 - a. Provide components, equipment, and devices that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products listed in the UL Fire Protection Equipment Directory (UL FPED) and that are labeled with their intended use or classification.
 - a) For various major sections of the fire pump system, partial listings or multiple listings are unacceptable.
 - 2) If a UL listing for a specific device is unavailable, products approved by FM Approvals LLC (FM) or another nationally recognized testing laboratory (NRTL) acceptable to the Sky Harbor International Airport Aviation Department will be acceptable.
 - 3) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.



- 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 1. Store and handle the fire pump equipment, conductors, devices, appliances, and other equipment and materials in accordance with the manufacturer's requirements.
 - a. Submit the manufacturer's written storage and handling requirements to the Program/Project Manager for information.
 2. Store materials in a neat and clean location that is protected from the elements so they are not subject to damage, moisture, or other reasonably foreseen circumstances.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Manufacturer Warranty:
 1. Have the manufacturer or the manufacturer's authorized representative warrant the new fire pump equipment against defects in material within the 2-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. Submit a written New Electrically Driven Fire Pump Materials Warranty, without monetary limitation, in which the manufacturer agrees to replace components of the new electrically driven fire pump that fail in materials within the specified warranty period to the Program/Project Manager for approval.
- B. Special Warranty:
 1. Warrant the new electrically driven fire pump equipment installed under this Contract against defects in workmanship and inherent mechanical and electrical defects within the 1-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.



- a. After the installation of the new electrically driven fire pump, prepare a signed written statement, substantially in the format that follows:
 - 1) "The undersigned, having been engaged as the Contractor for Contract [***insert the Contract number***] of the Phoenix Sky Train Project located in Phoenix, Arizona, confirms that the new electrically driven fire pump equipment provided under the Contract has been installed in accordance with the approved system Shop Drawings; the system manufacturer's wiring diagrams, installation instructions, and technical specifications; and the Contract Documents."
- b. Submit a written New Electrically Driven Fire Pump Workmanship Warranty, without monetary limitation and including the above signed written statement, in which the Contractor agrees to repair or replace components of the new electrically driven fire pump equipment installed under this Contract that fail in workmanship or exhibit inherent mechanical and/or electrical defects within the specified warranty period to the Program/Project Manager for approval.
 - 1) Indicate service work not included in the warranty, and furnish a price for providing a service contract to cover the work not covered by the warranty.

PART 2 PRODUCTS

2.01 FIRE PUMP SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. If manufacturers are listed for the products specified in this Section, subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified and approval by the Program/Project Manager, products from other manufacturers may be provided.
 3. Product Options:
 - a. Provide new equipment and system components of the first quality, of the manufacturer's best type, and the latest model capable of complying with the requirements specified in this Section
 - 1) Provide only new and unused equipment, devices, and appliances.
 - 2) Do not provide obsolete equipment.

- B. Description:



1. Regulatory Requirements:

a. Phoenix Building Construction Code and Phoenix Fire Code:

- 1) Perform the Work of this Section in compliance with the requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as amended by the City of Phoenix], and the Phoenix Fire Code and Amendments [ICC International Fire Code (IFC) as amended by the City of Phoenix].

C. Performance:

1. Pressure Ratings:

- a. Provide pumps and fittings having pressure ratings meeting or exceeding the maximum working pressures available within the fire suppression system, but not less than 175 pounds per square inch.

2. Fire Pump Densities:

- a. Provide fire pumps capable, at 100 percent of the motor rating, of pumping 1000 gallons per minute at a pressure of 75 pounds per square inch.
- b. Provide fire pumps capable of furnishing not less than 150 percent of the rated capacity at not less than 65 percent of the total rated head, and having a shutoff head limited to 140 percent of the total rated head.

3. Pressure-Maintenance-Pump Characteristics:

a. Rated Capacity:

- 1) Provide pressure-maintenance pumps rated for 5 gallons per minute.
- 2) Match the pressure-maintenance pump suction and discharge ratings as required for the pressure-maintenance pump capacity rating.

4. Seismic Performance:

- a. Provide pumps with bases and their attachment to the fire pumps, pressure-maintenance pumps, and controllers having reinforcement to resist the movement of the pumps and controllers during a seismic event when their bases are anchored to the building structure.
- b. Provide fire pump houses designed to resist the effects of seismic ground motions.

D. Design Criteria:

1. Equipment Locations:

- a. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.



- b. The actual location of the electric drive, centrifugal fire pump system equipment, controls, piping, valves, and drains are subject to the Program/Project Manager's approval.
 - c. Locate the pumps and controllers so access space is provided for performing periodic maintenance tasks, including space for removal of motors, impellers, couplings, and accessories.
 - 1) Install piping adjacent to the pumps and equipment so access space is provided for performing service and maintenance.
2. Provide new fire pumps, equipment, and system components listed by Underwriters Laboratories, Inc. (UL), or approved by Factory Mutual (FM), for their intended use.
3. Match the fire-pump suction and discharge ratings as required for the fire-pump capacity rating.
4. Fire Pump System Hydraulic Calculations:
 - a. Have the fire pump system Supplier's NICET-certified technical representative prepare hydraulic calculations for each fire pump system.
 - b. Submit the fire pump systems' hydraulic calculations to the Program/Program Manager for approval.
5. Fire Pump House Structural Requirements:
 - a. Live Load:
 - 1) Provide fire pump houses capable of resisting live loads of not less than 40 pounds per square foot applied on the horizontal projection of the fire pump house roof without failure.
 - b. Wind Load:
 - 1) Provide fire pump houses capable of resisting wind loads of not less than 110 miles per hour without failure.
6. Fire Pump Supplier's Compliance Plan and Reliability Information:
 - a. Prior to performing any of the other Work of this Section, prepare a written description of how the fire pump Supplier intends to comply with the operational design and performance requirements specified for the fire pump system, and pertinent information regarding the reliability and operation of the equipment proposed to be supplied, to the Program/Project Manager for approval.
 - b. Submit the fire pump Supplier's Compliance Plan and reliability information to the Program/Project Manager for review and approval.
7. Product Data:
 - a. Obtain the original manufacturer's Product Data for the new fire pumps, equipment, and system components, including specification sheets.
 - b. Equipment Lists:



- 1) Submit a Preliminary Equipment List identifying the type, quantity, make, and model number of each piece of fire pump system equipment to be provided under this Contract to the Program/Project Manager for approval.
 - a) Ensure that the types and quantities of equipment on the Preliminary Equipment List coincide with the types and quantities of equipment shown on the Shop Drawings.
 - b) Include the type, quantity, make, and model of spare equipment as specified in this Section.
 - c. Sequence of Operation:
 - 1) Prepare the sequence of operation for the electric drive, centrifugal fire pump system.
 - d. Submit the Product Data to the Program/Project Manager for approval.
8. Shop Drawings:
 - a. Prepare Shop Drawings of the fire pump system.
 - b. Prepare Working Drawings for installation of the fire pump system.
 - c. Submit the Shop Drawings and Working Drawings to the Program/Project Manager for approval.
 - 1) Do not commence the Work of this Section prior to approval of the Shop Drawings by the Program/Project Manager.
 - 2) Changes required in Work installed prior to approval of the Shop Drawings must be performed at no increase in the Contract Price.
9. Conflicts Arising Due to Discrepancies Between Documents:
 - a. Should conflicts arise due to discrepancies between documents referenced in this Section, the most stringent requirement applies; however, should a level of stringency be indeterminable, resolve the discrepancy as follows:
 - 1) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix, the National Fire Protection Association (NFPA) Standards, and this Section take precedence over the Contract Drawings.
 - 2) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix take precedence over the National Fire Protection Association (NFPA) Standards, this Section, and the Contract Drawings.
 - 3) The National Fire Protection Association (NFPA) Standards take precedence over this Section and the Contract Drawings.
 - 4) This Section takes precedence over the Contract Drawings.



E. Materials:

1. Fire Pump House

- a. Provide a factory-supplied pump house to house the fire pump equipped with the following appurtenances:
 - 1) Continuous duty exhaust fan.
 - 2) Motor operated louver.
 - 3) Heater with thermostat, and capable of generating 3kW to 50 kW of heat.
 - 4) Interior fluorescent lighting.
 - 5) Automatic sprinklers.
 - 6) Electrical distribution panel.

2. Fire Pump:

- a. Provide factory-assembled and factory-tested, single-stage, horizontally mounted, split-case, electric drive, centrifugal fire pumps complying with the requirements specified in UL 448, and having both pump and driver mounted on the same base and connected by a coupling.
- b. Pump:
 - 1) Unless otherwise indicated in the Contract Documents, provide an axially split cast-iron casing having suction and discharge flanges machined in accordance with the requirements for Class 125 dimensions specified in ASME B16.1.
 - a) Impellers:
 - (1) Provide cast bronze impellers matching the fire pump, statically and dynamically balanced, and keyed to the shaft.
 - b) Wear Rings:
 - (1) Provide replaceable, bronze wear rings.
 - c) Shafts and Sleeves:
 - (1) Provide steel shafts with bronze sleeves.
 - d) Shaft Bearings:
 - (1) Provide grease-lubricated ball bearings in cast-iron housings.
 - e) Seals:
 - (1) Provide seals consisting of a stuffing box having a minimum of 4 rings of graphite-impregnated braided yarn, and a bronze packing gland.
- c. Coupling:
 - 1) Provide a flexible coupling capable of absorbing torsional vibration and shaft misalignment.
 - 2) Provide a metal coupling guard.
- d. Driver:



- 1) Provide a UL-listed, open drip-proof, squirrel-cage, induction motor complying with the requirements specified in NEMA MG 1, NFPA 20, and NFPA 70.
- 2) Wire the driver so it is compatible with the controller provided.
- 3) Corrosion protection:
 - a) Protect piping and hangers exposed to the weather or installed in a corrosive atmosphere against corrosion.
 - b) Provide piping having a corrosion resistance rating ratio (CRR) greater than or equal to 1.0.
- 4) Fire Department Connections:
 - a) Provide electric drive, centrifugal fire pumps having the Fire Department connections shown on the Contract Drawings.
- e. Finish:
 - 1) Apply the manufacturer's standard red paint to the electric drive, centrifugal fire pumps before shipping them to the Site.
- f. Nameplate:
 - 1) Provide a nameplate, complete with the capacities, characteristics, and other pertinent data, on the electric drive, centrifugal fire pumps.
- g. Manufacturers:
 - 1) Pentair Pump Group, Aurora Pump, <http://www.aurorapump.com>.
 - 2) Approved equal.
3. Fire Pump Controllers:
 - a. Provide factory-assembled and factory-wired main fire pump controllers having a wired and tested power transfer switch, and complying with the requirements specified in NFPA 20 and NFPA 70.
 - 1) Provide fire pump controllers listed by Underwriters Laboratories, Inc. in accordance with the requirements specified in UL 218, and approved by FM Approvals LLC for fire pump service.
 - 2) Provide front mounted controller components, wired and front accessible for maintenance.
 - b. Starting Method
 - 1) Provide combined manual and automatic type controllers designed for solid state soft starting of a fire pump motor having the horsepower, voltage, phase and frequency rating shown on the Contract Drawings.
 - 2) House the controller components in a NEMA 2 (IEC IP11) Type drip-proof, wall mounted enclosure.
 - c. Withstand Ratings (Short Circuit Current Ratings):
 - 1) Provide fire pump controllers having a minimum withstand rating not less than 100,000 Amperes RMS symmetrical at 200 Volts to 600 Volts.



- 2) If the available system fault current exceeds these withstand ratings, supply controllers with a withstand rating of 150,000 Amperes RMS symmetrical or 200,000 Amperes RMS symmetrical, as required.
- d. Isolation Switch and Circuit Breaker:
 - 1) Provide controllers having a motor rated combination isolating disconnect switch/circuit breaker, mechanically interlocked and operated with a single, externally mounted handle.
 - a) Provide a locking type handle and three-point cam and roller vault type hardware for the controller door.
 - b) When the handle is moved from the OFF position to the ON position, the interlocking mechanism must first sequence the isolating disconnect switch to ON, and then sequence the circuit breaker to ON.
 - c) When the handle is moved from the ON position to the OFF position, the interlocking mechanism must first sequence the circuit breaker to OFF, and then sequence the isolating disconnect switch to OFF.
 - 2) Mechanically interlock the isolating disconnect switch/circuit breaker so the enclosure door cannot be opened with the handle in the ON position, except by a hidden tool operated defeater mechanism.
 - a) Provide an isolating disconnect switch/circuit breaker capable of being padlocked in the OFF position for installation and maintenance safety, and capable of being locked in the ON position without affecting the tripping characteristics of the circuit breaker.
 - 3) Factory set, test, and seal the circuit breaker trip curve adjustment to the full load amperes of the connected motor.
 - 4) Provide a circuit breaker capable of being field tested to verify the actual pick up, locked rotor, and instantaneous trip points after field installation without disturbing the incoming line and load conductors.
- e. Operator Interfaces:
 - 1) Provide fire pump controllers that feature an operator interface with a user keypad and a 2-line, 20-character, vacuum fluorescent, dot matrix type display designed to allow easy viewing from all angles and in all light conditions.
 - a) Provide operator displays and interfaces rated for NEMA 2, NEMA 3R, NEMA 4, NEMA 4X, and NEMA 12 Type protection in accordance with the requirements specified in



- NEMA 250, and that are fully accessible without opening the controller door.
- 2) Provide operator interfaces that monitor and display the motor operating conditions, including all alarms, events, and pressure conditions.
 - a) Provide an operator interface that displays all alarms, events, and pressure conditions with a time and date stamp.
 - 3) Provide system security by including multiple levels of password protection for the displays and user interfaces.
 - a) Provide a minimum of 3 password levels.
 - 4) Provide displays capable of being programmed for any software language.
- f. Ammeter/Voltmeter:
- 1) Provide fire pump controller operator interfaces capable of displaying true RMS digital motor voltage and current measurements for all 3 phases simultaneously.
 - a) Displays requiring push-buttons and selector switches to toggle between phases or current and voltage are unacceptable.
 - 2) Provide fire pump controller operator interfaces that use True RMS technology to measure voltage and current so the most accurate measurement of the waveforms, including non-sinusoidal waveforms, is made.
 - a) Average responding meters are unacceptable.
- g. Digital Status/Alarm Messages:
- 1) Provide digital displays capable of indicating status and alarm text messages for the following conditions:
 - a) Motor on.
 - b) Minimum run time.
 - c) Off delay time.
 - d) Fail to start.
 - e) Under voltage.
 - f) Locked rotor trip.
 - g) Over frequency.
 - h) Motor over 320.
 - i) Motor overload.
 - j) Printer error.
 - k) Sequential start time.
 - l) Local start.
 - m) Remote start.
 - n) System battery low.
 - o) Over voltage.



- p) Low suction pressure.
- q) Emergency start.
- r) Drive not installed.
- s) Disk error.
- t) Disk near full.
- h. Light Emitting Diode (LED) Visual Indicators:
 - 1) Provide digital displays having light emitting diode (LED) indicators capable of visibly indicating the following conditions with the door closed:
 - a) Power on.
 - b) Pump running.
 - c) Alarm.
 - d) Deluge open.
 - e) Phase failure.
 - f) Interlock on.
 - g) Emergency isolating switch open.
 - h) Low system pressure.
 - i) Transfer switch normal.
 - j) Transfer switch emergency.
 - k) Phase reversal.
- i. In addition to the standard alarm contacts required by NFPA 20, the digital display module must have N/O and N/C contacts for remote indication of any digitally displayed alarm, and N/O and N/C contacts for remote indication of up to 8 specified, programmable alarms.
- j. Data Logging:
 - 1) Provide digital displays capable of monitoring the system and logging the following data:
 - a) Motor calls/starts.
 - b) Last trip currents.
 - c) Last breaker trip.
 - d) Minimum voltages.
 - e) Maximum voltages.
 - f) Last phase failure.
 - g) Last phase reversal.
 - h) Minimum / maximum pressure.
 - i) Elapsed motor run time.
 - j) Elapsed power on time.
 - k) Maximum run currents.
 - l) Minimum run currents.
 - m) Last motor run time.
 - n) Last start currents.
 - o) Minimum / maximum frequency.



- k. Event Recording:
 - 1) Universal Serial Bus (USB) "Thumb" Drive:
 - a) Provide controllers equipped to save selectable data to a universal serial bus (USB) thumb drive.
 - 2) Memory:
 - a) Provide controllers that record all operational and alarm events in system memory.
 - (1) Provide controllers that time and date stamps all events, and includes an index number.
 - (2) Provide controllers having system memory capable of storing 3000 events, and of allowing the user to access the event log via the user interface.
 - (3) Provide controllers allowing the user to scroll through the stored messages in groups of 1, 10, or 100 messages.
 - 3) Communications:
 - a) Provide controllers that have 2 independent communications ports that allow connectivity to computers, modems, or building management systems.
 - 4) Solid State Pressure Transducer:
 - a) Provide controllers having a solid state pressure transducer with a range of 0 pounds per square inch (0bar) to 300 pounds per square inch (20.7bar) plus or minus 1 pound per square inch.
 - (1) Provide a solid state pressure switch that both displays the system pressure and controls of the fire pump controller.
 - (2) Systems using analog pressure devices or mercury switches for operational control are unacceptable.
 - b) Mount the pressure transducer inside the controller to prevent accidental damage.
 - (1) Directly pipe-mount the pressure transducer on a bulkhead pipe coupling without any other supporting members.
 - (2) Make field connections externally at the controller coupling to prevent distortion of the pressure switch element and mechanism.
 - 5) Provide controllers that allow START, STOP and SYSTEM PRESSURE to be digitally displayed and adjusted through the user interface.
 - 6) Controller Operation:
 - a) Provide controllers having a digitally set On Delay (Sequential Start) timer as standard.



- b) Upon a call to start, the user interface must display a message indicating the remaining time value of the On Delay timer.
- 7) For manual stop automatic stop, provide field programmable controllers.
 - a) If set for automatic stopping, the controller must allow the user to select either a Minimum Run Timer or an Off Delay Timer.
 - b) Both timers must be programmable through the user interface.
- 8) Provide fully programmable controllers that allow up to 8 custom alarm messages to be displayed on the user interface.
- 9) Provide nonadjustable restart delay timers that allow the residual voltage of the motor to decay prior to restarting the motor.
 - a) At least 2 seconds, but not more than 3 seconds, must elapse between stopping and restarting the pump motors.
- 10) Weekly Test Timer:
 - a) Provide a weekly test timer as a standard feature.
 - b) Provide controllers having the ability to program the time, date, and frequency of a weekly test.
 - c) Provide controllers having the capability to display a preventative maintenance message for a service inspection.
 - (1) The message text and frequency of occurrence must be programmable through the user interface.
- 11) Lamp Test Feature:
 - a) Provide controllers having a lamp test feature, and the ability to display the status of the system inputs and outputs on the user interface.
- 12) Provide controllers that cannot start the fire pump motor under a single-phase condition.
 - a) If the motor is already running when a phase loss occurs, the controller must continue to run the motor, but still display a Phase Failure alarm.
- I. Manufacturers:
 - 1) Firetrol, <http://www.firetrol.net>.
 - 2) Approved equal.

2.02 ACCESSORIES

A. Power Transfer Switch:

- 1. For switching each electric driven fire pump to a generator set emergency power source, provide a power transfer switch.
 - a. Provide factory assembled fire pump controller/power transfer switches, wired and tested as a unit prior to shipment.



2. Housing:
 - a. House the power transfer switches within the fire pump controller enclosure or in a NEMA 2 (IEC IP11) Type drip-proof enclosure attached directly to the fire pump controller.
 - 1) Where the power transfer switch is housed in an attached enclosure, fit the enclosure so the assembly constitutes a single unit.
 - b. Provide a locking type handle and three-point cam and roller vault type hardware for the power transfer switch door.
 3. Disconnect/Isolating Switches:
 - a. Provide power transfer switches having a motor rated disconnect/isolating switch capable of interrupting the motor locked rotor current.
 - b. Mechanically interlock the disconnect/isolating switches so the enclosure doors cannot be opened with the handles in the ON position, except by a hidden tool-operated defeater mechanism.
 - c. For installation and maintenance safety, provide disconnect/isolating switches capable of being padlocked in the OFF position with up to 3 padlocks and capable of being locked in the ON position.
 4. Provide an auxiliary contact on the transfer switch to prevent the emergency generator set from starting when the transfer switch or the main fire pump controller are being serviced.
 5. Provide transfer switch circuitry capable of sensing both the normal power source and the emergency power source.
 - a. Set the normal power source pickup at 95 percent of the nominal voltage.
 - b. Set the emergency power source to pick up at 90 percent of the nominal voltage and 95 percent of the nominal frequency.
 - c. To accommodate individual installation requirements, provide field adjustable voltage sensing, frequency sensing, and time delays.
 - d. Provide transfer switch circuitry capable of delaying the transfer signal for 1 second, delaying the transfer and engine start signals to compensate for momentary, normal power outages.
 - e. To allow the motor to slow sufficiently, preventing line disturbances that could trip either the generator set or fire pump circuit breakers, provide transfer switch circuitry capable of providing an automatic delay of 3 seconds upon transfer to or from the emergency power source.
- B. Fire Pump Accessories and Specialties:
1. Provide the following fire pump accessories and specialties:
 - a. Automatic air-release valve.



- b. Circulation relief valve.
 - c. Suction and discharge pressure gages.
 - d. Eccentric-tapered reducer at suction inlets.
 - e. Concentric-tapered reducer at discharge outlets.
 - f. Test-Header Manifold:
 - 1) Provide a ductile-iron or brass body test-header manifold for the hose valves.
 - a) Provide nozzle outlets arranged in a single line.
 - b) Provide a horizontal, flush-wall mounting attachment.
 - c) Provide a rectangular, brass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION".
 - g. Hose Valves:
 - 1) Provide bronze, straightway pattern hose valves complying with the requirements specified in UL 668, and having a cap and chain.
 - 2) Provide hose valves having hose threads complying with the requirements specified in NFPA 1963 and with local fire department standards.
 - 3) Finish:
 - a) Provide hose valves having the same finish as the test-header manifold escutcheon plate.
 - h. Ball Drip Valve:
 - 1) Provide ball drip valves complying with the requirements specified in UL 1726.
 - i. Main Relief Valve:
 - 1) Provide main relief valves complying with the requirements specified in UL 1478.
 - j. Finish:
 - 1) Provide the manufacturer's standard factory-applied red paint unless brass or another finish is specified.
- C. Pressure-Maintenance Pumps:
- 1. Provide factory-assembled and factory-tested pumps each having an electric-motor driver, a controller, and accessories and specialties.
 - a. Provide pressure-maintenance pumps having a cast-iron or stainless-steel casing, bronze or stainless-steel impellers, and mechanical seals; and, unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available, provide suction and discharge flanges machined in accordance with the requirements for Class 125 dimensions specified in ASME B16.1.
 - b. Finishes:



- 1) Apply the manufacturer's standard color paint to the factory-assembled and factory-tested pressure-maintenance pumps before shipping them to the Site.
- c. Nameplates:
 - 1) Provide nameplates complete with the capacity, characteristics, and other pertinent data for the pressure-maintenance pumps.
2. Multistage, Pressure-Maintenance Pumps:
 - a. Provide multiple-impeller type pressure-maintenance pumps complying with requirements for multistage centrifugal pumps; and having bases, suction and discharge pressure gages, and a circulation relief valve.
 - b. Drivers:
 - 1) Provide open-drip-proof, squirrel-cage pressure-maintenance pumps complying with the requirements specified in NEMA MG 1, and having induction motors complying with the requirements specified in NFPA 20 and NFPA 70.
 - 2) Wire the driver to be compatible with the controller used.
 - c. Controllers:
 - 1) Provide factory-assembled, factory-wired, and factory-tested, across-the-line type controllers complying with the requirements specified in UL 508, suitable combined automatic and manual operation, rated for the scheduled horsepower, and having the following accessories and specialties.
 - a) Fusible disconnect switches.
 - b) Pressure switches.
 - c) Hand-off-auto selector switches.
 - d) Pilot lights.
 - e) Running period timers.
 - d. Enclosures:
 - 1) For the pressure-maintenance pump controllers, provide wall-mounted enclosures complying with the requirements specified in UL 508, and with the requirements for NEMA 2 Type enclosures specified in NEMA 250, and of a type suitable for field electrical wiring.
 - e. Finishes:
 - 1) Apply the manufacturer's standard color paint to the factory-assembled and factory-tested controllers before shipping them to the Site.

D. Flow Meter Systems:

1. Provide a fire-pump flow meter system that indicates the flow to at least 175 percent of the rated capacity of the fire pump.



2. Pressure Rating:
 - a. Provide a fire-pump flow meter system rated for pressures of at least 200 pounds per square inch.
3. Flow Sensors:
 - a. Unless otherwise indicated, provide venturi, annubar probe, or orifice plate flow sensors.
 - b. Provide sensors sized to match the pipe, tubing, flow meter, and fittings.
4. Flow Meters:
 - a. Provide flow meters that are compatible with the flow sensor, and that have a dial at least 4-1/2 inches in diameter or of the manufacturer's equivalent size.
 - b. Permanently Mounted Flow Meters:
 - 1) Provide permanently mounted flow meters that are suitable for wall mounting, and that have copper tubing for connecting to the flow sensors.

E. Pressure Gages:

1. Provide pressure gages complying with the requirements specified in UL 393, and that have 3-1/2-inch diameter to 4-1/2-inch diameter dials that indicate pressure ranges of at least 0 pounds per square inch gage to 300 pounds per square inch gage.
2. Provide the caption "WATER" on dial faces of the pressure gages.

F. Grout:

1. Provide factory-mixed and factory-packaged non-staining, non-corrosive, and nongaseous grout complying with the requirements for dry, hydraulic-cement, non-shrink and nonmetallic grout specified in ASTM C 1107, and that is suitable for interior and exterior applications.
2. Design Mix:
 - a. Provide grout having a 28-day compressive strength of 5,000 pounds per square inch.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

Materials specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.



- a. Before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.
 2. National Fire Protection Association (NFPA) Test:
 - a. Test Procedure:
 - 1) Test and inspect fire pumps with their controllers in accordance with the methods for certified shop tests specified in NFPA 20.
 - 2) Submit certified test reports for the National Fire Protection Association (NFPA) Test for each fire pump to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Fire pumps having certified test reports showing the pump has complied with the requirements specified in NFPA 20 pass the National Fire Protection Association (NFPA) Test.
- B. Manufacturer Services:
 1. Verification of Performance:
 - a. Rate the fire pumps provided under this Section in accordance with the requirements specified in this Section.
- C. Coordination of Other Tests and Inspections:

Notify the code-required Approved Agency responsible for performing special inspections when electric driven, centrifugal fire pumps for this Contract are being fabricated and/or tested.

Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.

 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. The Contract Drawings indicate the numbers and prospective locations of system components, including the locations for the fire pumps.
 - a. Visit the Site, observe the existing conditions, and confirm that the indicated quantities of devices and the specific options for the locations shown are appropriate.
 2. Review the Contract Drawings, and become familiar with the conditions under which the work will be performed.
- B. Evaluation and Assessment:



Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the electric driven, centrifugal fire pump systems.

B. Surface Preparation:

Concrete Bases:

- a. Provide flat concrete pads to support each electrically driven fire pump and housing unit.
 - 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the electrically driven fire pump and housing unit.
 - 2) Extend the base not less than 3 inches in all directions beyond the maximum dimensions of the electrically driven fire pump and housing unit, unless otherwise indicated on the Contract Drawings, or unless required for seismic anchor support.
- b. Place and secure anchorage devices.
 - 1) Design each fastener and support in accordance with the seismic-restraint requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control, to carry the load indicated by seismic requirements and according to seismic-restraint details.
 - 2) Install anchor bolts to the elevations required for proper attachment to the electrically driven fire pump and housing unit.
 - a) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - b) Cast anchor-bolt inserts into the concrete bases.
- c. Construct the concrete bases in accordance with the seismic-restraint requirements specified in Section 15060, Hangers and Supports.
 - 1) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.

C. Demolition/Removal:

1. Remove scale and foreign debris from the fire suppression system piping.
2. Cutting and Patching Openings:



- a. Prior to performing structural Work, submit instructions for furnishing the openings and penetrations required for installing the electric fire pump systems to the Program/Project Manager for approval.
 - 1) Provide any subsequent additional penetrations or openings or relocations required, but not delineated in the original instructions, at no increase in Contract Price.

3.03 INSTALLATION

- A. Prior to installation, the equipment and materials must be clean inside and outside.
 1. Remove waste material, such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material, from the components before assembly.
 2. Attach pipe coupons or punched holes to the pipe near the pipe hole.
- B. Install and align fire pumps, pressure-maintenance pumps, and controllers in accordance with the requirements specified in NFPA 20.
 1. Install the electrically driven fire pumps in accordance with the approved Shop Drawings.
 2. Install new fire pumps, equipment, and system components within the limitations of their respective Underwriters Laboratories, Inc. (UL) listings or FM Approvals LLC (FM) approvals.
 3. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.
- C. Base-Mounted Pumps:
 1. Set base-mounted type pumps on concrete bases.
 2. Disconnect the drive coupling halves before setting the pumps.
 - a. Do not reconnect the couplings until alignment operations have been completed.
 3. Fire Pump Frame:
 - a. Support the pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, placed at points near anchor bolts so a 3/4-inch to 1-1/2-inch gap is provided between the pump base and the concrete base for grouting.
 - b. Adjust the metal supports or wedges until the pump and driver shafts are level.
 - 1) Verify that the coupling faces and pump suction and discharge flanges are level and plumb.
 - c. Fully grout the fire pump frame to the concrete base.
 - 1) With the metal blocks and shims or wedges in place, fill the base plate completely with grout.



d. Tighten the anchor bolts after the grout has hardened.

D. Controllers:

1. Properly connect the pump controllers to the pumps.
2. Properly connect the fire pump controllers to the building fire-alarm system.

E. Piping:

1. Aesthetics is a primary consideration when installing the system piping.
 - a. Any facet of installation that does not meet with the Program/Project Manager's approval must be revised to the Program/Project Manager's satisfaction.
2. Piping installation requirements are specified in other Sections.
3. Provide suction and discharge piping having diameters equal to or greater than the diameters of the fire-pump nozzles.
4. Support the pumps and the piping separately so the weight of the piping does not rest on the pumps.
5. Connect water supply and discharge piping to the fire pumps.
6. Connect water supply and discharge piping to the pressure-maintenance pumps.

F. Valves:

1. Provide valves that are the same size as the piping connecting the fire pumps, bypasses, test headers, and other piping systems.
2. Connect the relief-valve discharges to the point of disposal.

G. Meters and Gages:

1. Provide pressure gages on pressure-gage tapings at the fire-pump suction and discharge.
2. Provide flow meters and sensors at the locations indicated in the Contract Documents.
 - a. Install flow meter system sensors, meters, and other components, and make connections, in accordance with the flow meter system manufacturer's installation instructions.
 - b. Submit the flow meter system manufacturer's written installation instructions to the Program/Project Manager for information.

H. Special Techniques:

1. Alignment:
 - a. Align split-case fire pump and driver shafts after the complete unit has been leveled on its concrete base, the grout has set, and anchor bolts have been tightened.



- 1) Align vertically mounted, split-case pump and driver shafts after the complete unit has been made plumb on its concrete base, the grout has set, and its anchor bolts have been tightened.
 - b. Align the piping connections.
 - c. Align the pump and driver shafts so both angular and parallel alignment are within the tolerances specified by the pump and driver manufacturer.
 - d. After the alignment is correct, tighten the anchor bolts evenly.
 - e. Re-check the alignment, and make the corrections required.
 2. Electrical Grounding:
 - a. Ground the electric driven, centrifugal fire pump equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
- I. Interface with Other Work:
 1. Electrical Wiring:
 - a. Install the electrical devices furnished by the electric driven, centrifugal fire pump equipment manufacturer, but not specified to be factory-mounted.
 - b. Furnish copies of electrical device manufacturers' wiring diagram Submittals to the electrical installer.
 - c. Connect the wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.
- J. Systems Integration:
 1. Cooperation with Other Trades:
 - a. Coordinate installation of the electric driven, centrifugal fire pump systems with the Work of the other trades so construction progresses as rapidly and as smoothly as possible with a minimum of interference between trades.
 2. Work that is provided under other Sections but that is related to the sprinkler system includes, but is not limited to, the following:
 - a. Sprinkler Water Flow and Valve Supervisory Switches.
 - 1) Coordinate the connection of the tamper and water flow switches with the fire alarm system installation.
 - 2) Verify the quantity and location of the sprinkler water flow and supervisory switches, and test the switches in accordance with the requirements specified in NFPA 13 and NFPA 72.
 - 3) Devices for alarm monitoring of the water flow and valve supervisory switches will be provided under Section 13851, Fire Alarm.



3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

During the period when electric driven, centrifugal fire pumps are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.

- a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of electric driven, centrifugal fire pumps.
- b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
- c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

2. Test Plan:

- a. Prepare an Electric Driven, Centrifugal Fire Pump System Test Plan describing how the electric driven, centrifugal fire pump systems will be tested, and include a step-by-step description of all tests and the type and location of the test apparatus to be employed.
- b. Upon completion of the installation of each system and a minimum of 1 week prior to the Electric Driven, Centrifugal Fire Pump Pre-Acceptance Test, submit the Electric Driven, Centrifugal Fire Pump System Test Plan to the Program/Project Manager for approval.
 - 1) Do not perform any testing of the electric driven, centrifugal fire pump systems until the Electric Driven, Centrifugal Fire Pump System Test Plan is approved by the Program/Project Manager.
- c. Furnish the number, size, and length of fire hoses required to reach a storm drain or other acceptable location to dispose of fire-pump test water.
 - 1) These fire hoses are for field-acceptance tests only, and will not become the property of the Owner.

3. Leak Test and Inspection:

- a. Test Procedure:



- 1) After the fire pumps are installed, have the factory-authorized service representative charge the fire suppression system and test the fire pumps for leaks.
 - a) Perform the field tests for each fire pump after installation is complete.
 - b) Comply with the operating instructions and procedures specified in NFPA 20 to demonstrate compliance with the specified requirements.
- 2) Final Checks before Startup:
 - a) Perform the following preventive maintenance operations and checks before startup:
 - (1) Lubricate oil-lubrication-type bearings.
 - (2) Remove grease-lubrication-type bearing covers, flush these bearings with kerosene, and thoroughly clean the bearings.
 - (a) Fill the bearings with new lubricant in accordance with the grease-lubrication-type bearing manufacturer's lubrication instructions.
 - (b) Submit the grease-lubrication-type bearing manufacturer's written lubrication instructions to the Program/Project Manager for information.
 - (3) Disconnect the coupling, and check the electric motor for proper rotation.
 - (a) The rotation must match the direction of rotation marked on the pump casing.
 - (4) Verify that the fire pumps are free to rotate by hand.
 - (a) If a pump is bound, or if it drags even slightly, do not operate the pump until the cause of the trouble is determined and corrected.
- 3) Pump Starting Procedure:
 - a) Prime the pump by opening the suction valve and closing drains, and otherwise prepare the pump for operation.
 - b) If a pump is fitted with sealing-liquid supply valves, open these supply valves.
 - c) Start the motor.
 - d) Open the discharge valve slowly.
 - e) Observe if leakage is occurring from the stuffing boxes; and if so, adjust the sealing-liquid valve to furnish the flow that will ensure proper lubrication of the packing.
 - (1) Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.



- f) Check the general mechanical operation of pump and motor.
- g) Test and adjust the controls and safeties.
 - (1) Replace damaged and malfunctioning controls and equipment with properly functioning units.
- 4) Following the field tests and inspections, have the factory-authorized service representative prepare test reports documenting the results of the inspections and testing.
- b. Acceptance Criteria:
 - 1) Fire pumps that do not leak pass the Leak Test.

B. Non-Conforming Work

- 1. Do not install damaged system components.
- 2. Do not install system components if there is evidence that the components have manufacturer defects.
- 3. Repair fire pump system leaks, and retest the repaired pumps until no leaks exist.
 - a. Where possible, field correct malfunctioning equipment, and then retest the corrected equipment to demonstrate compliance with the specified requirements.
 - b. Replace equipment that cannot be satisfactorily corrected, or that does not perform as indicated, and then retest the replacement equipment to demonstrate compliance with the specified requirements.
 - c. Verify that each fire pump performs as specified.

C. Manufacturer Services:

- 1. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in the field testing.
 - a. Have the factory-authorized service representative submit the results of his or her inspections and testing in writing to the Program/Project Manager for information.

3.05 REPAIR/RESTORATION

- A. Repair damage to the skins and finishes of the station caused by installation of the electric driven, centrifugal fire pump system to the satisfaction of the Program/Project Manager at no increase in Contract Price.
- B. Holes:



1. Patch holes made in walls, ceilings, or floors, so the wall, ceiling, floor or member is restored to its original condition, fire resistance, and integrity.
- C. Touch up minor scratches to fire pump equipment and other accessories using paint and finish techniques matching those originally used on the items.

3.06 SYSTEM STARTUP

- A. Commissioning:
 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning; Section 15995, Commissioning of Mechanical Systems; and Section 16995, Commissioning of Electrical Systems, for the fire protection system Work of this Section.
- B. Startup Testing:
 1. After installation of the electric driven, centrifugal fire pump system has been completed, the preliminary tests have been completed, and deficiencies found have been corrected, and the system is ready for the Electric Driven, Centrifugal Fire Pump Pre-Acceptance Test, notify the Program/Project Manager in writing a minimum of 2 weeks in advance of this planned demonstration to arrange for the inspection and witnessing of the acceptance tests.
 2. Conduct the inspections and witness the acceptance testing.
 - a. The Pre-Acceptance Test is separate from the testing required by the local Authorities Having Jurisdiction.
 - 1) If the Authorities Having Jurisdiction (AHJ) are required to witness the tests, take responsibility for making the necessary arrangements with the code authorities, and for coordinating the work with the Program/Project Manager.
 - 2) Obtain the test documents from the Authorities Having Jurisdiction having the required approval stamps and signatures of the code authorities, and submit a copy of each of these documents to the Program/Project Manager.
 3. Perform the tests and inspections required by the referenced Codes and Standards, the Phoenix Fire Department, and the Program/Project Manager.
- C. Pre-Acceptance Test:
 1. Upon completion of each installation phase, perform and document on an approved format, the following electric driven, centrifugal fire pump system tests and procedures in the presence of the Program/Project Manager or their designed representative:



- a. Perform the Fire Pump and Controller Acceptance Test in accordance with the requirements specified by the manufacturer and in NFPA 20.
 - b. Flush the underground piping.
 - c. Test the monitor modules.
 - d. Perform a flow test from the test header.
 - e. Prepare a fire pump test report showing the fire pump curve including the churn, 100 percent, and 150 percent of the fire pump's rating and output.
2. Correct any errors, non-conformances, or non-performing components discovered during the Pre-Acceptance Test at no increase in the Contract Price.

D. Final Acceptance Test:

1. Upon completion of the Pre-Acceptance Test, perform and document in an approved format the following electric driven, centrifugal fire pump system tests in the presence of the Program/Project Manager, a designed representative, and the City of Phoenix Authorities Having Jurisdiction:
 - a. Perform the Fire Pump and Controller Acceptance Test in accordance with the requirements specified by the manufacturer and in NFPA 20.
 - b. Test the monitor modules.
 - c. Perform a flow test from the test header.
 - d. Prepare a fire pump test report showing the fire pump curve including the churn, 100 percent, and 150 percent of the fire pump's rating and output.

E. Final Approval:

1. Final approval and acceptance of the Work of this Section will only be given by the Program/Project Manager when the following items have been performed to the satisfaction of the Program/Project Manager:
 - a. The completed electric driven, centrifugal fire pump system has been inspected, tested, and approved by the Program/Project Manager and the City of Phoenix Fire and Development Services Departments.
 - b. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools, and training have been submitted to, and reviewed and accepted by the Program/Project Manager.
 - c. Additional Tests:
 - 1) Additional tests required by the referenced codes and standards, design criteria, or in writing by the Program/Project Manager have



been satisfactorily performed, and the following information regarding the tests has been submitted to the Program/Project Manager for information:

- a) Written directives requiring the additional tests.
- b) The date and time each test was performed.
- c) A description of each test performed.
- d) A checklist of each device tested, indicating the results of each test.
- e) A reference set of contractor record drawings, numerically identifying the individual components.

3.07 ADJUSTING

- A. Adjust the fittings to complete the turn-key fire pump system installation.

3.08 CLEANING

- A. After installation of the electric driven, centrifugal fire pump system, flush the entire fire pump system and suction pipe with clean water, either in sections or entirety in accordance with the method specified in NFPA 20, in order to remove all dirt and debris
 1. Continue the flushing operations for the systems for a time sufficient to ensure thorough cleaning, but not less than 10 minutes.
- B. At the end of the Contract, remove the equipment furnished for testing and flushing, and remove special equipment required for the installation of the Work of this Section.
- C. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 2. When performing flushing and other discharge testing, safely dispose of the waste water.

3.09 CLOSEOUT ACTIVITIES

- A. Training:
 1. To familiarize building personnel with the features, operation, and maintenance of the electric driven, centrifugal fire pump system conduct 2 training sessions of 4 hours each.
 - a. The Program/Project Manager will schedule the training sessions at a time mutually agreeable to the Contractor.
 - b. Final Agenda:



- 1) Submit the final approved training agenda to the Program/Project Manager 14 days prior to the first training session.

B. Record Set of Drawings:

1. Prepare a Record Set of Drawings recording the as-built electric driven, centrifugal fire pump system in conformance with the requirements specified in the Agreement and Section 01780, Closeout Submittals, to furnish information essential to those who test and maintain the electric driven, centrifugal fire pump system and account for all field changes made during installation.
 - a. During installation of the electric driven, centrifugal fire pump system, develop a Record Set of Drawings that include the original electric driven, centrifugal fire pump system Shop Drawings annotated to show exactly where the system components have been installed.
 - b. Furnish floor plans for the Record Set of Drawings showing the as-built information:
2. During the course of the Contract, develop an electronic version of the Record Set of Drawings for the electric driven, centrifugal fire pump system as a draft prepared using software and electronic media in accordance with the requirements specified in Section 01330, Submittal Procedures.
 - a. Show the equipment listed in this Section on a separate layer, and provide copies of this layer only on the floor plans furnished as part of the Record Set of Drawings for the electric driven, centrifugal fire pump system.
 - b. Update these draft as-built drawings every 24 hours during the installation of each electric driven, centrifugal fire pump system.
3. Make the onsite as-built Record Set of Drawings for the electric driven, centrifugal fire pump system available for inspection and review on request by the Program/Project Manager.
4. Submit the as-built Record Set of Drawings for the electric driven, centrifugal fire pump system as-built drawings to the Program/Project Manager for approval.
 - a. After the fire alarm system has been completely installed, and a minimum of 1 week prior to the Electric Driven, Centrifugal Fire Pump System Pre-Acceptance Test, submit an updated, as-built Record Set of Drawings for the electric driven, centrifugal fire pump system on electronic media that complies with the requirements specified in Section 01330, Submittal Procedures, to the Program/Project Manager for approval.



- b. After the Program/Project Manager approves the as-built Record Sets of Drawings for the electric driven, centrifugal fire pump system, they will be posted on Unifier for general distribution.

3.10 PROTECTION

- A. Provide caps over openings, even during and after assembly, to prevent foreign material from entering the pumps and pipe at any time.
 1. For example, pipe caps should be provided on the sprinkler extensions when the pipe is roughed in and the sprinklers are not yet installed.

3.11 MAINTENANCE

- A. Maintenance Materials:
 1. Obtain per unit costs for additional devices and appliances with firm prices to be maintained for 1 year beyond the duration of the manufacturer's warranty period as specified herein.
 2. Spare Parts List:
 - a. Prepare a suggested spare parts list of replacement electric driven, centrifugal fire pump system parts, with firm unit prices guaranteed to be maintained for the duration of the warranty period as specified herein for the manufacturer's-New Electrically Driven Fire Pump Materials Warranty.
 3. Submit the suggested spare parts list and the firm guaranteed unit prices for all of the maintenance materials to the Program/Project Manager for information.
- B. Maintenance Standards:
 1. Furnish and submit one copy each of NFPA 20 and NFPA 25 to the Program/Project Manager.
- C. Maintenance Contract:
 1. Submit a firm fixed price to furnish an Electrically Driven, Centrifugal Fire Pump System Maintenance Contract for covering a maintenance period of 1 year to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 13930

WET-PIPE FIRE SUPPRESSION SPRINKLERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Requirements for testing and inspection of all new sprinkler system components.
- B. Requirements for the installation of upright, pendant, and concealed sprinkler heads and pipe.

1.02 RELATED WORK

- A. Addressable monitor modules for the fire sprinkler system tamper and flow switches provided under Section 28 31 33, Fire Alarm, will be installed under this Section.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 02510 - Water Distribution.
 - 6. Section 07850 - Through Penetration Firestopping Systems.
 - 7. Section 09912 – Painting.
 - 8. Section 09960 - High-Performance Coatings.
 - 9. Section 13851 - Fire Alarm.
 - 10. Section 15995 - Commissioning of Mechanical Systems.
 - 11. Section 16995 - Commissioning of Electrical Systems.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CPVC: Chlorinated polyvinyl chloride.
 - 2. CRR: Corrosion resistance ratio.
 - 3. DPDT: Double pole, double throw.
 - 4. FACU: Fire Alarm Control Unit.
 - 5. GMP: Guaranteed Maximum Price.
 - 6. MSDS: Material Safety Data Sheet(s).
 - 7. NICET: National Institute for Certification in Engineering Technology.
 - 8. NRTL: Nationally Recognized Testing Laboratory.
 - 9. OS&Y: Outside screw and yoke.



10. UL FPED: Underwriter's Laboratory, Inc. Fire Protection Equipment Directory.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA); which meets the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory; and which tests for safety and lists or labels or accepts equipment or materials.
3. Contractor's Material and Test Certificate: A document that acknowledges the features of the installation, operation (performance), service, and equipment with representation by the property owner, system installer, System Supplier, service organization, and the Authority Having Jurisdiction.
4. Refer to Subparagraph 3.06.B.1 for additional details regarding the Record of Completion. Corrosion Resistance Ratio (CRR): An Underwriters Laboratory, Inc. term for the estimated life expectancy of a pipe joint based on the calculated wall thickness at the base of the first exposed thread, assumed to be the weakest point of the pipe length.
5. Unifier: The web based management software/database system the Phoenix Sky Harbor International Airport (PSHIA) uses to manage all correspondence, requests for interpretation (RFI), submittals, and similar information related to construction activities for the Phoenix Sky Train Project.

1.04 CODES

- A. Compliance with the following Codes and Standards are required for the project.
1. International Building Code (IBC) – 2012 with City of Phoenix amendments
 2. International Fire Code (IFC) – 2012 with City of Phoenix amendments
 3. Requirements of the Phoenix Fire Department and Aviation Design Guide.
 4. Annual Facilities Permit Program Registration Packet.
 5. American Society of Mechanical Engineers (ASME):
 - a. ASME B16.39 – Malleable Iron Threaded Pipe Unions: Classes 150, 250, 300.
 6. ASTM International (ASTM):



- a. ASTM A 795/A 795M – Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
7. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
8. International Code Council (ICC):
 - a. International Building Code – 2012 (IBC) with City of Phoenix amendments.
 - b. International Fire Code – 2012 (IFC) with City of Phoenix amendments.
9. National Fire Protection Association (NFPA):
 - a. NFPA 13 - Standard for the Installation of Sprinkler Systems (2013).
 - b. NFPA 25 – Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (2013).
 - c. NFPA 70 - National Electrical Code® (NEC) (2011 as adopted by the City of Phoenix).
 - d. NFPA 72 – National Fire Alarm and Signaling Code (2013).
10. Underwriter's Laboratory (UL):
 - a. UL Fire Protection Equipment Directory (FPED).
11. UL Online Certifications Directory,

1.05 SCOPE OF WORK

- A. The installation of a fire sprinkler system in the South Concourse.
- B. Install and support the new sprinkler pipe as required by NFPA 13.
- C. Install and support new sprinkler heads in accordance with NFPA 13

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Prior to commencement and after completion of the Work of this Section, provide written notification to the Program/Project Manager.
 2. Coordinate the impairment planning for tying the combination wet-pipe fire suppression sprinkler system into the existing fire sprinkler water supply mains with the City of Phoenix Fire and Aviation Departments.
 - a. Bear the cost of the impairment coordination.
 - b. Comply with the time allotments granted by the Authorities Having Jurisdiction for the fire sprinkler system tie-in to the existing fire sprinkler water supply mains.
 3. Coordinate with the Program/Project Manager, the Commissioning Authority (CA), the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and



- Inspection Agency, Commissioning Authority (CA), and the City prior to incorporating items requiring testing by them into the Work.
4. Coordinate the installation and testing of the automatic wet-pipe fire sprinkler system and the associated equipment and circuits with the appropriate Subcontractors, equipment maintenance and testing representatives, the Sky Harbor International Airport Aviation Department, and the Authorities Having Jurisdiction.
 - a. Coordinate the connection of the tamper and water flow switches with the installation of the fire alarm.
 - b. Coordinate the Pre-Acceptance and the Final Acceptance Test of the automatic wet-pipe fire sprinkler system specified herein with the Program/Project Manager, the Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction (AHJ).
 - 1) Furnish at least 5 working days advance notice for all tests.
 - 2) At the time of notification, submit 1 copy of the approved Record Set of Drawings and the approved System Test Plan to the Program/Project Manager.
 - c. Final Acceptance Test:
 - 1) In order to assure attendance at the Final Acceptance Test by the necessary representatives, provide reasonable notification of the test date to each representative scheduled to witness the test at least 48 hours prior to the test.
 - 2) Do not conduct this test until all parties agree on a test date.
 5. Coordinate the dates and times of each required training session as specified herein through the Sky Harbor International Airport Aviation Department, not less than 2 weeks prior to the training session.
- B. Sequencing:
1. Complete the installation of the combination automatic wet-pipe fire suppression sprinkler system components so the fire alarm equipment Supplier can make the final connections and conduct tests of the fire alarm system as specified in other Sections without delaying the Work.
 2. Complete the installation of the combination automatic wet-pipe fire sprinkler system components to facilitate the scheduled cut-in to the fire sprinkler water supply mains.
- C. Scheduling:
1. Prior to beginning the Work of this Section, submit a schedule indicating the wet-pipe fire suppression sprinkler system installation sequence and time frame to the Program/Project Manager for approval.
 - a. Include specific time lines indicating the start and completion of major portions of each new combination automatic wet-pipe fire sprinkler system installation.
 - b. Include time lines indicating the start and completion of impairments of the existing fire sprinkler system.



- c. Indicate the delivery dates of the equipment to be supplied.
- d. Indicate the dates for the automatic wet-pipe fire sprinkler system Pre-Acceptance Test and the Final Acceptance Test specified herein.
2. Provide weekly schedule updates to the Program/Project Manager for approval.
3. Advise the Program/Project Manager of all anticipated projects the Contractor and the equipment Supplier may have with the same approximate completion date as this Contract, and what impact those projects may have on the timely completion of this Contract.

1.07 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pipe and fittings.
 - 2) Pipe hangers and supports.
 - 3) Control and drain valves.
 - 4) Sprinklers.
 - 5) Identification signs.
 - 6) Supervisory and alarm equipment.
 - 7) Inspector's test and drain assemblies.
 - 8) Hose valve connections.
 - 9) Access panels.
 - b. Shop Drawings:
 - 1) Shop Drawings for the combination wet-pipe fire suppression sprinkler system.
 - 2) Working Drawings for installation of the combination wet-pipe fire suppression sprinkler system.
 - c. Certificates:
 - 1) Contractor's Material and Test Certification for Above Ground Piping.
 - d. Delegated Design Submittals:
 - 1) Hydraulic calculations.
 - 2) Valve chart.
 - 3) Preliminary Equipment List.
 - 4) Sequence of operation.
 - 5) Schedule indicating the automatic wet-pipe fire sprinkler system installation sequence and time frame, and weekly schedule updates.
 - 6) Training agenda.
 - e. Special Procedure Submittals:



- 1) Instructions for furnishing the openings and penetrations required for installing the combination wet-pipe fire suppression sprinkler system.
- 2) Automatic wet-pipe fire sprinkler system Test Plan.
- f. Qualification Statements:
 - 1) Qualifications of the wet-pipe fire suppression sprinkler system installer.
 - 2) Qualifications of the automatic wet-pipe fire sprinkler system NICET certified technician responsible for supervising the installation.
 - 3) Qualifications of the wet-pipe fire sprinkler system manufacturer's NICET certified technician responsible for preparing the automatic wet-pipe fire sprinkler standpipe system Shop Drawings and calculations.
- B. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Firm fixed price for a 1 year Combination automatic wet-pipe fire sprinkler standpipe system Maintenance Contract.
 - b. Operation and Maintenance Data:
 - 1) Spare Parts List.
 - 2) A copy of NFPA 25.
 - c. Warranty Documentation:
 - 1) Automatic wet-pipe fire suppression sprinkler system Materials Warranty.
 - 2) Automatic wet-pipe fire suppression sprinkler system Workmanship Warranty.
 - d. Record Documentation:
 - 1) Record Set of Drawings.
- C. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare automatic wet-pipe fire sprinkler system products in accordance with the requirements specified in NFPA 13 and that match the products installed.
 - b. Tools:
 - 1) Furnish a sprinkler head wrench.

1.08 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:



1. Authorities Having Jurisdiction:
 - a. To obtain approval of the combination automatic wet-pipe fire sprinkler system by the Program/Project Manager, the City of Phoenix Fire Department, Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction, documents prepared according to the requirements specified in NFPA 13 and the City of Phoenix Annual Facilities Permit Program Registration Packet, including Shop Drawings, hydraulic calculations, and water flow test results are required.
 - 1) An inspector's drawings apply to the Work of this Section.
 - 2) Submit these documents and the required fees to the Annual Facilities Permit Program, attention Mary Schilling, for review and approval.
 - 3) Submit the fire protection system Permit received to the Program/Project Manager.
- B. Impairment coordination
- C. The fire alarm system impairment (taken off line for work by the Contractor) shall be planned and coordinated in accordance with the International Fire Code with City of Phoenix Amendments Section 901.7.4
- D. Qualifications:
 1. Automatic wet-pipe fire sprinkler system Installer's Qualifications:
 - a. Employ a firm that is licensed in the State of Arizona, and that has a minimum of 5 years of documented experience installing fire sprinkler systems similar in type to those required for this Contract.
 - b. Employ a firm that has installed fire sprinkler systems for projects similar in scope to this Contract, and that has obtained design and inspection approvals for similar projects from the Authorities Having Jurisdiction.
 - c. Submit the qualifications of the proposed system installer and the resume of the proposed system installer's foreman and project manager-assigned to this Contract to the Program/Project Manager for approval.
 - 1) Include the number of years the proposed sprinkler system installer has been in business, and their service policies, warranty definitions, and prior experience with installations that include the type of equipment that is to be supplied under this Contract.
 - a) Furnish a list of at least 3 installations similar in scope to this Contract, including the addresses of the properties, contact names, telephone numbers, and the types of system equipment installed.
 - 2) Include proposed automatic wet-pipe fire sprinkler system installer's personnel and company contact information.



- a) Furnish sufficient information to describe the qualifications of the proposed representatives, the work efforts to be performed, and the materials to be provided, and include the names and qualifications of the Contractor's project manager who will be in responsible charge during installation of the automatic wet-pipe fire sprinkler system.
- d. Nonconformance of the proposed automatic wet-pipe fire sprinkler system installer's qualifications with the qualifications specified in this Section are cause for immediate elimination without further comment.
- e. Do not replace an approved installer or the approved foreman without the written approval of the Program/Project Manager.
 - 1) No requested change in Subcontractor will be accepted unless justification is made in writing to the Program/Project Manager and approved.
 - a) Upon written request, the Program/Project Manager may authorize changes, but the decision to do so is at the sole choice and discretion of the Program/Project Manager.
- 2. Automatic wet-pipe fire sprinkler system Technical Representative's Qualifications:
 - a. To supervise the field installation of the automatic wet-pipe fire sprinkler system provided under this Contract, employ a trained and qualified representative who, at a minimum, holds a current NICET Level II Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification.
 - 1) Submit the name and qualifications of the proposed technical representative who will be in responsible charge of the installation of the system under this Contract to the Program/Project Manager for approval.
 - a) Furnish sufficient information to describe the qualifications of the proposed representative, the work efforts to be performed, and the materials to be provided.
 - 2) Do not replace an approved technical representative without the written approval of the Program/Project Manager.
 - b. The specified automatic wet-pipe fire sprinkler system Shop Drawings and calculations must be prepared by a certified technician holding at a minimum NICET Level III Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification or be a licensed Fire Protection Engineer in the State of Arizona.
 - 1) Submit the name and qualifications of the proposed certified technician who will be responsible for preparing the automatic wet-pipe fire sprinkler system Shop Drawings and calculations under this Contract to the Program/Project Manager for approval.
 - a) Furnish sufficient information to describe the qualifications of the proposed technician, the work efforts to be performed, and the materials to be provided.



E. Certifications:

1. Listing and Labeling of Components, Devices, and Accessories:

- a. Provide only components, equipment, and devices that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories (NRTL) are not available or unless standards do not exist for the products.
 - 1) Provide products listed in the UL Fire Protection Equipment Directory (UL FPED) and that are labeled with their intended use or classification.
 - a) For various major sections of the wet-pipe fire suppression sprinkler system, partial listings or multiple listings are unacceptable.
 - 2) If a UL listing for a specific device is unavailable, products approved by FM Approvals LLC (FM) or another nationally recognized testing laboratory (NRTL) acceptable to the Sky Harbor International Airport Aviation Department will be acceptable.
 - 3) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.

B. Storage and Handling Requirements:

1. Store materials in a neat and clean location that is protected from the elements and damage.
 - a. Store materials so they are not subject to damage, moisture, or other reasonably unforeseen circumstances.
2. Store and handle all equipment, devices, appliances, and other equipment and materials in accordance with the manufacturer's requirements.



C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.10 WARRANTY

A. Manufacturer Warranty:

1. Have the manufacturer or the manufacturer's authorized representative warrant the new automatic wet-pipe fire sprinkler system materials against defects in material within the 2-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. Submit a written Automatic wet-pipe fire sprinkler system Materials Warranty, without monetary limitation, in which the manufacturer agrees to replace components of the new combination wet-pipe fire suppression sprinkler system that fail in materials within the specified warranty period to the Program/Project Manager for approval.

B. Special Warranty:

1. Warrant the automatic wet-pipe fire sprinkler system installed under this Contract against defects in workmanship and inherent mechanical and electrical defects within the 1-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. After the installation of each automatic wet-pipe fire sprinkler system, submit a signed written statement, substantially in the format that follows, to the Program/Project Manager:
 - 1) "The undersigned, having been engaged as the Contractor for Contract [*insert the Contract number*] of the Phoenix Sky Train Project located in Phoenix, Arizona, confirms that the combination wet pipe fire sprinkler standpipe system equipment provided under the Contract has been installed in accordance with the approved system Shop Drawings, the manufacturer's installation instructions and technical specifications; and the Contract Documents."
 - b. Submit a written Automatic wet-pipe fire sprinkler system Workmanship Warranty, without monetary limitation, in which the Contractor agrees to repair or replace components of the new automatic wet-pipe fire sprinkler system installed under this Contract that fail in workmanship or exhibit inherent mechanical and/or electrical defects within the specified warranty period to the Program/Project Manager for approval.
 - 1) Indicate service work not included in the warranty, and furnish a price for providing a service contract to cover the work not covered by the warranty.



PART 2 PRODUCTS

2.01 WET-PIPE FIRE SUPPRESSION SPRINKLER SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. If manufacturers are listed for the products specified in this Section, subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified and approval by the Program/Project Manager, products from other manufacturers may be provided.
 - 3. Product Options:
 - a. Provide new equipment and system components of the first quality, of the manufacturer's best type, and the latest model capable of complying with the requirements specified in this Section
 - 1) Provide only new and unused equipment, devices, and appliances.
 - 2) Do not provide obsolete equipment.
- B. Description:
 - 1. The Work of this Section consists of providing a new automatic wet pipe fire sprinkler standpipe system.
 - a. One new riser must be installed as shown on the Contract Drawings.
 - b. Furnish and install necessary control valves, fitting, components, and connections for a system that complies with NFPA 13.
 - c. Furnish the equipment necessary for testing and any special equipment required for the installation of the Work of this Section.
 - 2. Regulatory Requirements:
 - a. IBC and IFC:
 - 1) Perform the Work of this Section in compliance with the requirements of the IBC and IFC.
- C. Design Criteria:
 - 1. General Locations:
 - a. The actual location of the automatic wet-pipe fire sprinkler system equipment, controls, piping, valves, and drains are subject to Program/Project Manager's approval.
 - 2. Deflector Distances:
 - a. Install permanently installed sprinklers so the deflector-to-ceiling distances are in accordance with the requirements specified in NFPA 13.
 - 1) Take the ceiling design into consideration when designing deflector to ceiling distances in the pedestrian walkways.



- 2) Refer to the Contract Drawings for further information regarding deflector to ceiling distances.
3. Sprinkler Piping:
 - a. Sprinkler piping on any floor level may cross building structural separations, such as expansion and seismic joints, provided that the piping is specifically designed with flexible connections at each crossing and is able to accommodate the calculated differential motions during an earthquake in accordance with the IBC as Amended by the City of Phoenix and NFPA 13.
 - 1) Employ a qualified Professional Engineer to perform the required structural, differential movement, and drift calculations.
 - 2) Verify the locations of seismic joints.
 - b. Conceal the sprinkler piping installed in public areas or non-public areas with suspended ceilings in the walls and/or ceilings.
 - c. Pipe in unfinished areas may be exposed.
 - d. Pipe Sizes:
 - 1) For all branch line piping except in gridded systems, provide piping having nominal pipe diameters of at least 1 inch unless otherwise shown on the contract drawings.
 - 2) For all branch line piping in gridded systems, provide piping having nominal pipe diameters of at least 1-1/4 inch unless otherwise shown on the contract documents.
 - e. Pressure Ratings:
 - 1) Provide fittings having pressure ratings meeting or exceeding the maximum working pressures available within the automatic wet-pipe fire sprinkler system. The minimum pressure rating shall be 175 psi.
 - f. Corrosion Protection:
 - 1) Where the piping and hangers are exposed to the weather or installed in a corrosive atmosphere, protect the piping and hangers against corrosion.
 - 2) Provide piping having a corrosion resistance ratio (CRR) greater than or equal to 1.0.
4. Sprinklers:
 - a. Under ducts, stairs, and other obstructions, provide sprinklers in accordance with the requirements specified in NFPA 13.
 - b. Densities:
 - 1) Design the system to produce the following sprinkler discharge densities:
 - a) Light Hazard:
 - (1) Over the hydraulically most remote 1,500 square feet throughout the building, design the system to furnish 0.10 gallons per minute per square foot.
 - b) Ordinary Hazard:



- (1) Over the hydraulically most remote 1,500 square feet in selected areas, design the system to furnish 0.15 gallons per minute per square foot.
5. Sprinkler Head Cabinet:
 - a. Locate the sprinkler head cabinet for storing spare sprinkler heads where indicated by the Program/Project Manager.
6. Valves:
 - a. Pressure Ratings:
 - 1) Provide valves having pressure ratings meeting or exceeding the maximum working pressures available within the combination wet-pipe fire suppression sprinkler system, but rated for not less than 175 psi.
 - b. Supervision:
 - 1) Provide control valves that are locked and electrically supervised.
7. Conflicts Arising Due to Discrepancies between Documents:
 - a. Should conflicts arise due to discrepancies between documents referenced in this Section, the most stringent requirement applies; however, should a level of stringency be indeterminable, resolve the discrepancy as follows:
 - 1) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix, the National Fire Protection Association (NFPA) Standards, and this Section take precedence over the Contract Drawings.
 - 2) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix take precedence over the National Fire Protection Association (NFPA) Standards, this Section, and the Contract Drawings.
 - 3) The National Fire Protection Association (NFPA) Standards take precedence over this Section and the Contract Drawings.
 - 4) This Section takes precedence over the Contract Drawings.
8. Product Data:
 - a. Obtain Product Data, including the original manufacturer's specification sheets, for the products provide as the Work of this Section.
 - 1) Submit the Product Data to the Program/Project Manager for approval.
 - b. Equipment Lists:
 - 1) Submit a Preliminary Equipment List identifying the type, quantity, make, and model number of each piece of automatic wet-pipe fire sprinkler system equipment to be provided under this Contract to the Program/Project Manager for approval.



- a) Ensure that the types and quantities of equipment on the Preliminary Equipment List coincide with the types and quantities of equipment shown on the Shop Drawings.
 - b) Include the type, quantity, make, and model of spare equipment as specified in this Section.
 - 9. Shop Drawings:
 - a. Prepare Shop Drawings for the automatic wet-pipe fire sprinkler system.
 - 1) Include a riser diagram of the system.
 - 2) Indicate the location of the inspector's test and drain valve on the Shop Drawings and riser diagram.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
 - 1) Do not commence the Work of this Section prior to approval of the Shop Drawings by the Program/Project Manager.
 - 2) Changes required in Work installed prior to approval of the Shop Drawings must be performed at no increase in the Contract Price.
 - 10. Calculations.
 - a. Have the NICET III technician perform hydraulic calculations for the automatic wet-pipe fire sprinkler system assuming the following hose stream flows:
 - 1) Inside Hose Stream: 100 gallons per minute.
 - 2) Combined (Inside and Outside) Hose Stream: 250 gallons per minute located at the base of the riser.
 - b. Submit the calculations to the Program/Project Manager for approval.
- D. Sequence of Operation:
 - 1. Submit a sequence of operation describing how the automatic wet-pipe fire sprinkler system will respond during alarm, supervisory, and trouble conditions to the Program/Project Manager for approval.
 - a. Provide sufficient information so the exact function of each installed device and appliance is known.
- E. Materials:
 - 1. Pipe and Fittings:
 - a. Aboveground Piping Components:
 - 1) 2-Inch and Larger Pipe Sizes:
 - a) For piping having nominal pipe sizes of 2 inches and larger, provide piping complying with the requirements for Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A black steel pipe specified in ASTM A 795/A 795M, except that for nominal pipe sizes of 8 inches (200mm) and greater in diameter Schedule 30 pipe is acceptable; or an equal approved by the Program/Project Manager.
 - b) Pipe Joints:



- (1) Only provide steel pipes designed to be joined using flanges welded to the pipe or by using mechanical grooved joint systems.
 - (2) Do not provide pipe designed to be joined by welding or weld fittings.
- 2) 2-Inch and Smaller Pipe Sizes:
 - a) For piping having nominal pipe sizes of 2 inches and smaller, provide piping complying with the requirements for Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A steel pipe specified in ASTM A 795/A 795M having threaded end connections; or an equal approved by the Program/Project Manager.
 - b) Fittings:
 - (1) Provide fittings complying with the requirements for Class 150 threaded fittings specified in ASME B16.39.
 - c) Unions:
 - (1) Provide unions complying with the requirements for Class 150 unions specified in ASME B16.39.
- 3) Copper pipe or tube is unacceptable.
- 4) Chlorinated polyvinyl chloride (CPVC) pipe is unacceptable
2. Pipe Hangers and Supports:
 - a. Provide adjustable pipe hangers and supports that are listed in the UL Fire Protection Directory or FM Global Approval Guide.
 - 1) Zinc-plate the rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.
 - 2) Do not mix pipe hanger and support components of different manufacturers.
3. Control and Drain Valves:
 - a. Provide control and drain valves for the automatic wet-pipe fire sprinkler system of the following types:
 - 1) Gate Valves:
 - a) Provide outside screw and yoke (OS&Y) type gate valves.
 - 2) Butterfly Valves:
 - a) Provide butterfly valves that are approved for use in sprinkler systems; and for butterfly valves that have integral valve supervisory switches, ensure that the entire assembly is approved for use in sprinkler systems.
 - b. Signs:
 - 1) Permanently mark all water supply control valves and drain valves with metal signs that show their function and the sprinkler system zone which they serve.
 - 2) Prepare a valve chart to be mounted at the fire alarm control unit (FACU), and submit a copy of the valve chart to the Program/Project Manager for approval.
4. Sprinklers:



- a. Provide quick response, 165 degree Fahrenheit sprinklers unless otherwise shown on the contract drawings.
- b. Uniformity:
 - 1) Within the same space, only provide sprinklers from the same manufacturer and that each have the same heat response element, including the same temperature rating and response characteristics.
- c. Corrosion Resistance:
 - 1) For sprinklers located on exterior piping systems, provide corrosion resistant sprinklers.
- d. Sprinkler Escutcheons:
 - 1) Provide metal escutcheons listed with the sprinklers for recessed sprinkler locations.
- e. Sprinkler Orifice:
 - 1) Unless specifically approved otherwise by the Program/Project Manager, provide standard orifice sprinklers (1/2-inch orifice).
- 5. Identification Signs:
 - a. Required Information:
 - 1) Provide hydraulic calculation signs that include the information indicated in Appendix A of NFPA 13.
 - 2) Provide valve identification signs that identify the function of the valve and the area served.
 - 3) Provide a sign identifying the riser room in accordance with the IFC Appendix D.
 - b. Provide signs consisting of rigid, flat steel or aluminum plaques having an embossed enamel background and lettering.
- 6. Supervisory and Alarm Equipment:
 - a. Provide water flow and valve supervisory switches each having 2 "Form C" (DPDT.) contacts for monitoring.
 - 1) Coordinate specific contact ratings with the fire alarm Supplier.
 - b. Water Flow Switches:
 - 1) Provide vane-type water flow indicators capable of indicating the water flow in each sprinkler system zone.
 - c. Supervisory Switches:
 - 1) Provide valve supervisory switches of the loop type, either yoke mounted or integral type.
 - 2) Do not provide remote mounted, wire loop type switches.
- 7. Inspector's Test and Drain Assemblies:
 - a. Provide test and drain assemblies for the wet-pipe systems that comply with the requirements specified in NFPA 13.
 - 1) This test and drain assembly may be a modular unit type.

F. Finishes:

- 1. The paint colors and finishes for materials must be approved in writing by the Project/Program Manager.



- a. The Program/Project Manager will select the finishes for the automatic sprinklers and escutcheons from the manufacturer's standard range.
- b. The Program/Project Manager will select the finishes for the access panels.

2.02 ACCESSORIES

- A. Access Panels:
 1. Provide access panels at least 12-inches by 12-inches in size.
 2. For access panels to be installed in fire resistive construction, provide the types required to maintain the proper protection of the protected assembly.

2.03 SEISMIC JOINT

- A. Metroflex or pre-approved equal.
- B. Flexible couplings installed in accordance with NFPA 13.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. The Contract Drawings indicate the numbers and prospective locations of system components, including the locations for sprinklers, branch lines, and standpipes and risers.
 - a. Visit the Site, observe the existing conditions, and confirm that the indicated quantities of devices and the specific options for the locations shown are appropriate.
 2. Review the Contract Drawings, and become familiar with the conditions under which the work will be performed.
- B. Evaluation and Assessment:
 1. If deviations from the approved Shop Drawings are necessary, notify the Program/Project Manager.
 - a. Prior to installation of the deviations, obtain approval in writing from the Program/Project Manager, and update the as-built drawings to reflect the changes subsequent to making the changes.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the automatic wet-pipe fire sprinkler system.



B. Demolition/Removal:

1. Cutting and Patching Openings:

- a. Prior to performing structural Work, submit instructions for furnishing the openings and penetrations required for installing the combination wet-pipe fire suppression sprinkler system to the Program/Project Manager for approval.
 - 1) Provide any subsequent additional penetrations or openings or relocations required, but not delineated in the original instructions, at no increase in Contract Price.

3.03 INSTALLATION

- A. Prior to installation, ensure that the equipment and materials are clean inside and outside.
- B. Remove all waste material, such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material, from the components before assembly.
- C. Attach pipe coupons or punched holes to the pipe near the pipe hole.
- D. Install the automatic wet-pipe fire sprinkler system's sprinklers and equipment in accordance with the approved Shop Drawings, the limitations of the respective UL listings or FM approvals, and the manufacturer's installation instructions.
 1. Submit the automatic wet-pipe fire sprinkler system manufacturer's written installation instructions to the Program/Project manager for information.
 2. Employ special tools recommended by the manufacturer for installing the system.
 3. Aesthetics is a major consideration when installing sprinklers and sprinkler piping.
 - a. Revise sprinkler installation not meeting with the Program/Project Manager's approval to the satisfaction of the Program/Project Manager.
- E. Exposed Piping:
 1. Remove scale and foreign debris from the system piping.
 2. Minimum Height:
 - a. Install exposed piping and devices as high as possible, but not less than 7-feet 0-inches above the finished floor in traffic or working areas.
 3. Install exposed piping and devices so they do not obstruct any portion of a window, doorway, stairway or passageway; and do not interfere with the operation or accessibility of any mechanical, plumbing or electrical equipment.
 4. Sway Bracing, Flexible Couplings, Hangers:



- a. Design and install the flexible couplings, hangers and sway bracing in accordance with the requirements specified in NFPA 13, including its appendices.
 - 1) Allow for flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structures, so no allowable stresses are exceeded in any member.
5. Pipe Coatings:
 - a. Paint the piping exposed within the building public areas in accordance with the requirements specified in Section 09912, Painting.
 - b. Paint the system materials including but not limited to pipe, fittings, fasteners, and hangers installed above the Aerobreeze ceiling.
 - c. Prime exterior piping with zinc chromate, and paint the exterior piping in accordance with the requirements specified in Section 09960, High-Performance Coatings.
 - d. Apply the colors selected by the Program/Project Manager.
6. Escutcheon Plates:
 - a. Provide escutcheon plates for exposed pipe which passes through a wall, ceiling, or floor.
7. For all piping 2-1/2 inches and larger in diameter, provide labels at 20-foot intervals to indicate the piping is sprinkler system piping.
 - a. Stencil the words: fire sprinkler system in a contrasting color.
 - b. Apply the colors selected by the Program/Project Manager.
- F. Risers:
 1. Locate the main risers and standpipes for the sprinkler system in the locations approved by the Program/Project Manager, and so obstruction of traffic or building operations is minimized.
- G. Sprinklers:
 1. Unless otherwise approved by the Program/Project Manager, center sprinklers in finished areas in the center of a ceiling tile plus or minus 2 inches.
- H. Valves:
 1. Install valves that controlling the water supply to the sprinkler systems less than 7-feet 0-inches above the finished floor.
 - a. When specifically approved by the Program/Project Manager, these valves may be installed higher if they are provided with operating chains.
 2. Supervisory Switches:
 - a. Provide valve supervisory switches for all valves controlling the water supply to the sprinkler and standpipe systems, including valves located at backflow preventers.



- I. Signs:
 - 1. Provide hydraulic calculation signs for each new sprinkler zone.
 - a. Install hydraulic calculation signs on the riser of each system in a workmanlike manner.
 - 2. Provide identification signs for the valves installed under this Section.
 - a. Secure signs by chain or durable wire to each sprinkler zone control valve, or in an obvious location specifically approved by the Program/Project Manager.
 - 3. Provide a sign identifying the location of the fire sprinkler riser room in accordance with IFC Appendix D.
- J. Inspector's Test and Drain Assembly:
 - 1. Provide an inspector's test and drain assembly at the most hydraulically remote part of the sprinkler system.
 - 2. Discharge:
 - a. Hard pipe the test connections and drain riser connections as shown in the mechanical drawings.
 - 1) Coordinate the routing of the drain pipe with the Program/Project Manager and other Work.
- K. Access Panels:
 - 1. Install access panels for the control valves located above finished ceilings or concealed in walls.
 - 2. For access panels installed in fire resistive construction, provide the types of access panels required to maintain the proper protection of assembly.
- L. Interface with Other Work:
 - 1. Firestopping:
 - a. Sleeve and grout or seal pipe which passes through fire-resistive barriers, including shaft walls, to maintain the integrity and rating of the fire resistive barrier.
 - b. Provide material for through penetration fire stopping complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems, and that is compatible with the sprinkler piping.
- M. Systems Integration:
 - 1. Cooperation with Other Trades:
 - a. Coordinate installation of the automatic wet-pipe fire sprinkler system with the work of the other trades so construction progresses as rapidly and as smoothly as possible with a minimum of interference between trades.
 - 2. Work that is provided under other Sections but that is related to the sprinkler system includes, but is not limited to, the following:
 - a. Sprinkler Water Flow and Valve Supervisory Switches.



- 1) Coordinate the connection of the tamper and water flow switches with the fire alarm system installation.
- 2) Verify the quantity and location of the sprinkler water flow and supervisory switches, and test the switches in accordance with the requirements specified in NFPA 13 and NFPA 72.
- 3) Devices for alarm monitoring of the water flow and valve supervisory switches will be provided by others.

3.04 REPAIR/RESTORATION

- A. Holes:
 1. Patch holes made in walls, ceilings, or floors, so the wall, ceiling, floor or member is restored to its original condition, fire resistance, and integrity.
- B. Repair damage to finishes caused by installation of the automatic wet-pipe fire sprinkler system to the satisfaction of the Program/Project Manager at no increase in Contract Price.
- C. Touch up minor scratches to sprinkler pipe and other accessories using paint and finish techniques matching those originally used on the items.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Automatic wet-pipe fire sprinkler system Test Plan:
 - a. Prepare an automatic wet-pipe fire sprinkler system Test Plan describing how the automatic wet-pipe fire sprinkler system will be tested, and include a step-by-step description of all tests and the type and location of the test apparatus to be employed.
 - b. Upon completion of the installation of each system and a minimum of 1 week prior to the Automatic wet-pipe fire sprinkler system Pre-Acceptance Test, submit the Automatic wet-pipe fire sprinkler system Test Plan to the Program/Project Manager for approval.
 - c. Do not test the automatic wet-pipe fire sprinkler system until the Automatic wet-pipe fire sprinkler system Test Plan is approved by the Program/Project Manager.
 2. Hydrostatic Test:
 - a. Test Procedure:
 - 1) Prior to acceptance of the automatic wet-pipe fire sprinkler system by the Program/Project Manager, hydrostatically test the system in accordance with the method specified in NFPA 13.
 - b. Acceptance Criteria:
 - 1) Pressure drop within the limits required by NFPA 13.
- B. Non-Conforming Work
 1. Repair or replace nonconforming installation.



2. Do not install system components that are damaged.
3. Do not install system components where there is evidence of manufacturer defects.

3.06 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning; Section 15995, Commissioning of Mechanical Systems; and Section 16995, Commissioning of Electrical Systems, for the fire protection system Work of this Section.

B. Startup Testing:

1. Prior to the Pre-Acceptance Test, submit 2 copies of the Contractor's Material and Test Certification for Above Ground Piping prepared in accordance with the requirements specified in NFPA 13 to the Program/Project Manager for information.
2. After installation of the automatic wet-pipe fire sprinkler system has been completed, the preliminary tests have been completed, and deficiencies found have been corrected, and the system is ready for the Automatic wet-pipe fire sprinkler system Pre-Acceptance Test, notify the Program/Project Manager in writing a minimum of 2 weeks in advance of this planned demonstration to arrange for the inspection and witnessing of the acceptance tests.
3. Conduct the inspections and witness the acceptance testing.
 - a. This acceptance testing is separate from the testing required by the local Authorities Having Jurisdiction.
 - 1) When local code authorities are required to witness tests, take responsibility for making the necessary arrangements with the code authorities, and for coordinating the work with the Program/Project Manager.
 - 2) Obtain the test documents from the Authorities Having Jurisdiction having the required approval stamps and signatures of the code authorities, and submit a copy of each of these documents to the Program/Project Manager.

C. Pre-Acceptance Test:

1. Perform the tests and inspections required by the referenced Codes and Standards, the Phoenix Fire Department, and the Program/Project Manager.
 - a. Upon completion of each installation phase, perform and document on an approved format, the following automatic wet-pipe fire sprinkler system tests in the presence of the Program/Project Manager or their designed representative:



- 1) Hydrostatic tests.
 - 2) Test of the sprinkler supervisory system.
 - 3) Flow test from the inspector's test connection.
 - b. Correct any errors, non-conformances, or non-performing components discovered during the Pre-Acceptance Test at no increase in the Contract Price.
2. Final Acceptance Test:
 - a. Upon completion of the Pre-Acceptance Test, perform and document in an approved format the following automatic wet-pipe fire sprinkler system tests in the presence of the Program/Project Manager, a designed representative, and the City of Phoenix Authorities Having Jurisdiction:
 - 1) Hydrostatic tests.
 - 2) Flushing of piping.
 - 3) Test of the sprinkler supervisory system.
 - 4) Flow test from the inspector's test connection.
3. Final Approval:
 - a. Final approval and acceptance of the Work of this Section will only be given by the Program/Project Manager when the following items have been performed to the satisfaction of the Program/Project Manager:
 - 1) The completed automatic wet pipe sprinkler system has been inspected, tested, and approved by the Program/Project Manager and the City of Phoenix Fire and Development Services Departments.
 - 2) Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools, and training have been provided to, reviewed, and accepted by the Program/Project Manager.
 - 3) Additional Tests:
 - a) Additional tests required by the referenced codes and standards, design criteria, or the Program/Project Manager have been satisfactorily performed, and the following information regarding the tests has been submitted to the Program/Project Manager for information:
 - (1) Written directive requiring the additional tests.
 - (2) The date and time each test was performed.
 - (3) A description of each test performed.
 - (4) A checklist of each device tested, indicating the results of each test.
 - (5) A reference set of contractor record drawings, numerically identifying the individual components.



3.07 ADJUSTING

- A. Adjust the fittings and hangars to complete the turn-key fire sprinkler system installation.
- B. Properly adjust the water flow and valve supervisory switches.

3.08 CLEANING

- A. Clean up sprinkler system installation debris during fabrication and installation of system components.
- B. At the end of the Contract, remove the equipment furnished for testing and remove special equipment required for the installation of the Work of this Section.
- C. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 - 2. When performing flushing and other discharge testing, safely dispose of the water.

3.09 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. To familiarize building personnel with the features, operation, and maintenance of the sprinkler system conduct 2 training sessions of 4 hours each.
 - a. The Program/Project Manager will schedule the training sessions at a time mutually agreeable to the Contractor.
 - b. Final Agenda:
 - 1) Submit the final approved training agenda to the Program/Project Manager 14 days prior to the first training session.
- B. Record Set of Drawings:
 - 1. Prepare a Record Set of Drawings recording the as-built automatic wet-pipe fire sprinkler system in conformance with the requirements specified in the Agreement and Section 01780, Closeout Submittals, to furnish information essential to those who test and maintain the automatic wet-pipe fire sprinkler system and account for all field changes made during installation.
 - a. During installation of the automatic wet-pipe fire sprinkler system, develop a Record Set of Drawings that include the original system Shop Drawings annotated to show exactly where the system components have been installed.



- b. Furnish floor plans for the Record Set of Drawings showing the as-built information:
 2. During the course of the Contract, develop an electronic version of the Record Set of Drawings for the automatic wet-pipe fire sprinkler system as a draft prepared using software and electronic media in accordance with the requirements specified in Section 01330, Submittal Procedures.
 - a. Show the equipment listed in this Section on a separate layer, and provide copies of this layer only on the floor plans furnished as part of the Record Set of Drawings for the automatic wet-pipe fire sprinkler system.
 - b. Update these draft as-built drawings every 24 hours during the installation of each automatic wet-pipe fire sprinkler system.
 3. Make the onsite as-built Record Set of Drawings for the automatic wet-pipe fire sprinkler system available for inspection and review on request by the Program/Project Manager.
 4. Submit the as-built Record Set of Drawings for the automatic wet-pipe fire sprinkler system as-built drawings to the Program/Project Manager for approval.
 - a. After the fire alarm system has been completely installed, and a minimum of 1 week prior to the Automatic wet-pipe fire sprinkler system Pre-Acceptance Test, submit an updated, as-built Record Set of Drawings for the automatic wet-pipe fire sprinkler system on electronic media that complies with the requirements specified in Section 01330, Submittal Procedures, to the Program/Project Manager for approval.
 - b. After the Program/Project Manager approves the as-built Record Sets of Drawings for the automatic wet-pipe fire sprinkler system, they will be posted on Skier for general distribution.

3.10 PROTECTION

- A. Protect valves and assemblies exposed to potential damage by vehicles or other traffic by providing a cage for the valves and assemblies located inside the building, or guard posts for exterior hydrants and post indicator valves.
- B. For installed piping, valves, devices or accessories which, in the Program/Project Manager's opinion, are subject to physical damage or may be hazards, provide adequate permanent protection
 1. The protective measures to be implemented must be approved by the Program/Project Manager prior to implementation:
- C. To prevent foreign material from entering the piping, furnish caps over openings during and after assembly
 1. For example, pipe caps should be provided on the sprinkler extensions when the pipe is roughed in and the sprinklers are not yet installed.



3.11 MAINTENANCE

A. Spare Parts List:

1. Submit a suggested spare parts list of replacement automatic wet-pipe fire sprinkler system parts, with firm unit prices guaranteed to be maintained for the duration of the warranty period as specified herein for the manufacturer's-Combination Wet-Pipe Fire Suppression Sprinkler System Materials Warranty, to the Program/Project Manager.

B. Maintenance Standard:

1. Furnish and submit a copy of NFPA 25 to the Program/Project Manager.

C. Maintenance Contract:

1. Submit a firm fixed price to furnish a Combination Wet-Pipe Fire Suppression Sprinkler System Maintenance Contract for covering a maintenance period of 1 year to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/0132017	N/A	All	First edition.



SECTION 13931

COMBINATION AUTOMATIC WET-PIPE FIRE SUPPRESSION SPRINKLER STANDPIPE SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for installation of a combination automatic wet pipe fire sprinkler and manual wet standpipe systems for the 24th Street and Rental Car Center (RCC) Sky Train stations as indicated in the Contract Documents.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Addressable monitor modules for the fire sprinkler system tamper and flow switches provided under Section 13851, Fire Alarm, will be installed under this Section.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 07850 - Through Penetration Firestopping Systems.
 - 6. Section 09912 – Painting.
 - 7. Section 09960 - High-Performance Coatings.
 - 8. Section 13851 - Fire Alarm.
 - 9. Section 15995 - Commissioning of Mechanical Systems.
 - 10. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CPVC: Chlorinated polyvinyl chloride.
 - 2. CRR: Corrosion resistance ratio.
 - 3. DPDT: Double pole, double throw.
 - 4. FACU: Fire Alarm Control Unit.
 - 5. MSDS: Material Safety Data Sheet(s).
 - 6. NICET: National Institute for Certification in Engineering Technology.
 - 7. NRTL: Nationally Recognized Testing Laboratory.
 - 8. OS&Y: Outside screw and yoke.



9. UL FPED: Underwriter's Laboratory, Inc. Fire Protection Equipment Directory.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA); which meets the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory; and which tests for safety and lists or labels or accepts equipment or materials.
3. Contractor's Material and Test Certificate: A document that acknowledges the features of the installation, operation (performance), service, and equipment with representation by the property owner, system installer, system Supplier, service organization, and the Authority Having Jurisdiction.
 - a. Refer to Subparagraph 3.06.B.1 for additional details regarding the Contractor's Material and Test Certification.
4. Corrosion Resistance Ratio (CRR): An Underwriters Laboratory, Inc. term for the estimated life expectancy of a pipe joint based on the calculated wall thickness at the base of the first exposed thread, assumed to be the weakest point of the pipe length.
5. Unifier: The web based management software/database system the Phoenix Sky Harbor International Airport (PSHIA) uses to manage all correspondence, requests for interpretation (RFI), submittals, and similar information related to construction activities for the Phoenix Sky Train Project.

C. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
 - a. ASME B16.39 – Malleable Iron Threaded Pipe Unions: Classes 150, 250, 300.
2. ASTM International (ASTM):
 - a. ASTM A 795/A 795M – Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
 - b. Annual Facilities Permit Program Registration Packet.
3. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
4. International Code Council (ICC):
 - a. ICC International Building Code - 2012 (IBC) as Amended by the City of Phoenix.



- b. ICC International Fire Code - 2012 (IFC) as Amended by the City of Phoenix.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 13 – (2013) Standard for the Installation of Sprinkler Systems.
 - b. NFPA 14 – (2013) Installation of Standpipe and Hose Systems.
 - c. NFPA 25 – (2013) Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
 - d. NFPA 70 – (2011) National Electrical Code® (NEC) with City of Phoenix amendments.
 - e. NFPA 72 – (2013) National Fire Alarm and Signaling Code.
- 6. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - a. Fire Protection Engineering Technology Automatic Sprinkler System Layout Program Detail Manual.
- 7. Underwriters Laboratories, Inc. (UL):
 - a. UL 497B - Standard for Protectors for Data Communication and Fire Alarm Circuits.
 - b. UL 864 - Standard for Control Units and Accessories for Fire Alarm Systems.
 - c. UL 1971 - Standard for Signaling Devices for the Hearing Impaired.
 - d. UL Fire Protection Equipment Directory (FPED).
 - e. UL Online Certifications Directory, <http://www.ul.com/regulators/quickguide.html>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Prior to commencement and after completion of the Work of this Section, provide written notification to the Program/Project Manager.
 - 2. Coordinate with the Program/Project Manager, the Commissioning Authority (CA), the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, Commissioning Authority (CA), and the City prior to incorporating items requiring testing by them into the Work.
 - 3. Coordinate the installation and testing of the combination automatic wet-pipe fire suppression sprinkler system and the associated equipment and circuits with the appropriate Subcontractors, equipment maintenance and testing representatives, the Sky Harbor International Airport Aviation Department, and the Authorities Having Jurisdiction.
 - a. Coordinate the connection of the tamper and water flow switches with the installation of the fire alarm.



- b. Coordinate the Pre-Acceptance and the Final Acceptance Test of the combination automatic wet-pipe fire suppression sprinkler and standpipe system specified herein with the Program/Project Manager, the Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction (AHJ).
 - 1) Furnish at least 5 working days advance notice for all tests.
 - 2) At the time of notification, submit 1 copy of the approved Record Set of Drawings and the approved System Test Plan to the Program/Project Manager.
 - c. Final Acceptance Test:
 - 1) In order to assure attendance at the Final Acceptance Test by the necessary representatives, provide reasonable notification of the test date to each representative scheduled to witness the test at least 48 hours prior to the test.
 - 2) Do not conduct this test until all parties agree on a test date.
 - 4. Coordinate the dates and times of each required training session as specified herein through the Sky Harbor International Airport Aviation Department, not less than 2 weeks prior to the training session.
- B. Sequencing:
 - 1. Complete the installation of the combination wet-pipe fire suppression sprinkler standpipe system components so the fire alarm equipment supplier can make the final connections and conduct tests of the fire alarm system as specified in other Sections without delaying the Work.
 - 2. Complete the installation of the combination wet-pipe fire suppression sprinkler standpipe system components to facilitate the scheduled cut-in to the fire sprinkler water supply mains.
- C. Scheduling:
 - 1. Prior to beginning the Work of this Section, submit a schedule indicating the wet-pipe fire suppression sprinkler standpipe system installation sequence and time frame to the Program/Project Manager for approval.
 - a. Include specific time lines indicating the start and completion of major portions of each new combination automatic wet-pipe fire suppression sprinkler standpipe system installation.
 - b. Include time lines indicating the start and completion of impairments of the existing fire sprinkler system.
 - c. Indicate the delivery dates of the equipment to be supplied.
 - d. Indicate the dates for the combination automatic wet-pipe fire suppression sprinkler system Pre-Acceptance Test and the Final Acceptance Test specified herein.
 - 2. Provide weekly schedule updates to the Program/Project Manager for approval.



3. Advise the Program/Project Manager of all anticipated projects the Contractor and the equipment Supplier may have with the same approximate completion date as this Contract, and what impact those projects may have on the timely completion of this Contract.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Densities: Hydraulically calculated sprinkler systems shall be installed in accordance with the construction documents. The systems have been designed to produce discharge densities of:
 - a. 0.15 gpm/square foot over the hydraulically most remote 1,500 (Ordinary Hazard Group 1).
 - b. 0.2 gpm/square foot over the hydraulically most remote 1,500 (Ordinary Hazard Group 2)
2. Develop and submit shop drawings.
3. Hose requirements: NFPA 14 flow requirements.
4. The standpipe system shall be designed so that the required flow is delivered to the hose valve connection at 130 psi. This is a City of Phoenix Fire Department Requirement and is not negotiable.
5. Sprinklers under ducts (or other): Provide sprinklers under ducts and obstructions as required by NFPA 13.
6. All branch line piping shall be 1" minimum.
7. All hydraulically calculated sprinkler systems shall provide a minimum safety factor in accordance with IFC Section 903.3.5.3.
8. Separate area control valve assemblies shall be provided for the pre-action sprinkler system.
9. Water supply information shall be obtained from the local water authority where the project is located. The Contractor is required to calculate pressure losses due to elevation and friction through all fittings, piping, and valves in accordance with NFPA 13.

1.05 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pipe and fittings.
 - 2) Pipe hangers and supports.
 - 3) Sprinklers.
 - 4) Identification signs.
 - 5) Supervisory and alarm equipment.



- 6) Hose valve connections.
 - b. Shop Drawings:
 - 1) Shop Drawings for the combination wet-pipe fire suppression sprinkler standpipe system.
 - 2) Working Drawings for installation of the combination wet-pipe fire suppression sprinkler standpipe system.
 - c. Certificates:
 - 1) Contractor's Material and Test Certification for above ground piping.
 - d. Delegated Design Submittals:
 - 1) Hydraulic calculations.
 - 2) Valve chart.
 - 3) Preliminary Equipment List.
 - 4) Schedule indicating the combination automatic wet-pipe fire suppression sprinkler standpipe system installation sequence and time frame, and weekly schedule updates.
 - 5) Training agenda.
 - e. Special Procedure Submittals:
 - 1) Instructions for furnishing the openings and penetrations required for installing the combination wet-pipe fire suppression sprinkler standpipe system.
 - 2) Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Test Plan.
 - f. Qualification Statements:
 - 1) Qualifications of the combination wet-pipe fire suppression sprinkler standpipe system installer.
 - 2) Qualifications of the combination wet-pipe fire suppression sprinkler standpipe system manufacturer's technical representative.
 - 3) Qualifications of the combination wet-pipe fire suppression sprinkler standpipe system manufacturer's certified technician responsible for preparing the combination automatic wet-pipe fire suppression sprinkler standpipe system Shop Drawings and calculations.
- B. Closeout Submittals:
- 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Firm fixed price for a 1 year Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Maintenance Contract.
 - b. Operation and Maintenance Data:
 - 1) Spare Parts List.



- 2) A copy of NFPA 25.
 - c. Warranty Documentation:
 - 1) Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Materials Warranty.
 - 2) Combination Wet Pipe Fire Sprinkler Standpipe System Workmanship Warranty.
 - d. Record Documentation:
 - 1) Record Set of Drawings.
- C. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - b. Furnish spare combination automatic wet-pipe fire suppression sprinkler standpipe system products in accordance with the requirements specified in NFPA 13 and that match the products installed. A minimum of six (6) sprinkler heads of each type used on the systems shall be provided in a cabinet where indicated by the Program/Project Manager Tools:
 - 1) Furnish a sprinkler head wrench.

1.06 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Authorities Having Jurisdiction:
 - a. To obtain approval of the combination wet-pipe fire suppression sprinkler standpipe system by the Program/Project Manager, the City of Phoenix Fire Department, Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction, documents prepared according to the requirements specified in NFPA 13, NFPA 14, and the City of Phoenix Annual Facilities Permit Program Registration Packet, including Shop Drawings, hydraulic calculations, and water flow test results are required.
 - 1) An inspector's drawings apply to the Work of this Section.
 - 2) Submit these documents and the required fees to the Annual Facilities Permit Program, attention Mary Schilling, for review and approval.
 - 3) Submit the fire protection system Permit received to the Program/Project Manager.
- B. Qualifications:
 - 1. Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Installer's Qualifications:



- a. Employ a firm that is licensed in the State of Arizona, and that has a minimum of 5 years of documented experience installing fire sprinkler and standpipe systems similar in type to those required for this Contract.
- b. Employ a firm that has installed fire sprinkler and standpipe systems for projects similar in scope to this Contract, and that has obtained design and inspection approvals for similar projects from the Authorities Having Jurisdiction.
- c. Submit the qualifications of the proposed system installer and the resume of the proposed system installer's foreman and project manager-assigned to this Contract to the Program/Project Manager for approval.
 - 1) Include the number of years the proposed combination wet-pipe fire suppression sprinkler standpipe system installer has been in business, and their service policies, warranty definitions, and prior experience with installations that include the type of equipment that is to be supplied under this Contract.
 - a) Furnish a list of at least 3 installations similar in scope to this Contract, including the addresses of the properties, contact names, telephone numbers, and the types of system equipment installed.
 - 2) Include proposed combination wet-pipe fire suppression sprinkler standpipe system installer's personnel and company contact information.
 - a) Furnish sufficient information to describe the qualifications of the proposed representatives, the work efforts to be performed, and the materials to be provided, and include the names and qualifications of the Contractor's project manager who will be in responsible charge during installation of the combination wet-pipe fire suppression sprinkler standpipe system.
- d. Nonconformance of the proposed combination wet-pipe fire suppression sprinkler standpipe system installer's qualifications with the qualifications specified in this Section are cause for immediate elimination of the proposed wet-pipe fire suppression sprinkler system installer without further comment.
- e. Do not replace an approved combination wet-pipe fire suppression sprinkler system installer or the approved installer's foreman without the written approval of the Program/Project Manager.
 - 1) No requested change in Subcontractor will be accepted unless justification is made in writing to the Program/Project Manager and approved.



- a) Upon written request, the Program/Project Manager may authorize changes, but the decision to do so is at the sole choice and discretion of the Program/Project Manager.
 2. Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Technical Representative's Qualifications:
 - a. To supervise the field installation of the combination wet-pipe fire suppression sprinkler standpipe system provided under this Contract, employ a trained and qualified manufacturer's technical representative who, at a minimum, holds a current NICET Level II Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification.
 - 1) Submit the name and qualifications of the proposed combination wet-pipe fire suppression sprinkler standpipe system manufacturer's technical representative who will be in responsible charge of the installation of the wet-pipe fire suppression sprinkler system under this Contract to the Program/Project Manager for approval.
 - a) Furnish sufficient information to describe the qualifications of the proposed representative, the work efforts to be performed, and the materials to be provided.
 - 2) Do not replace an approved manufacturer's technical representative without the written approval of the Program/Project Manager.
 - b. The specified combination wet-pipe fire suppression sprinkler standpipe system Shop Drawings and calculations must be prepared by a certified technician holding at a minimum NICET Level III Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification or State of Arizona Licensed Fire Protection Engineer.
 - 1) Submit the name and qualifications of the proposed combination wet-pipe fire suppression sprinkler standpipe system certified technician who will be responsible for preparing the Shop Drawings and calculations under this Contract to the Program/Project Manager for approval.
- C. Certifications:
 1. Listing and Labeling of Components, Devices, and Accessories:
 - a. Provide only components, equipment, and devices that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized



testing laboratories (NRTL) are not available or unless standards do not exist for the products.

- 1) Provide products listed in the UL Fire Protection Equipment Directory (UL FPED) and that are labeled with their intended use or classification.
- 2) If a UL listing for a specific device is unavailable, products approved by FM Approvals LLC (FM) or another nationally recognized testing laboratory (NRTL) acceptable to the Sky Harbor International Airport Aviation Department will be acceptable.
- 3) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 1. Store materials in a neat and clean location that is protected from the elements and damage.
 - a. Store materials so they are not subject to damage, moisture, or other reasonably unforeseen circumstances.
 2. Store and handle all equipment, devices, appliances, and other equipment and materials in accordance with the manufacturer's requirements.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.08 SITE CONDITIONS

1. Not applicable.



1.09 WARRANTY

A. Manufacturer Warranty:

1. Have the manufacturer or the manufacturer's authorized representative warrant the new combination wet-pipe fire suppression sprinkler standpipe system materials against defects in material within the 2-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. Submit a written Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Materials Warranty, without monetary limitation, in which the manufacturer agrees to replace components of the new combination wet-pipe fire suppression sprinkler standpipe system that fail in materials within the specified warranty period to the Program/Project Manager for approval.

B. Special Warranty:

1. Warrant the combination wet-pipe fire suppression sprinkler standpipe system installed under this Contract against defects in workmanship and inherent mechanical and electrical defects within the 1-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. After the installation of each wet-pipe fire suppression sprinkler system, submit a signed written statement, substantially in the format that follows, to the Program/Project Manager:
 - 1) "The undersigned, having been engaged as the Contractor for Contract [***insert the Contract number***] of the Phoenix Sky Train Project located in Phoenix, Arizona, confirms that the combination wet pipe fire sprinkler standpipe system equipment provided under the Contract has been installed in accordance with the approved system Shop Drawings, the manufacturer's installation instructions and technical specifications; and the Contract Documents."
 - b. Submit a written Combination Wet Pipe Fire Sprinkler Standpipe System Workmanship Warranty, without monetary limitation, in which the Contractor agrees to repair or replace components of the new wet-pipe fire suppression sprinkler system installed under this Contract that fail in workmanship or exhibit inherent mechanical and/or electrical defects within the specified warranty period to the Program/Project Manager for approval.
 - 1) Indicate service work not included in the warranty, and furnish a price for providing a service contract to cover the work not covered by the warranty.



PART 2 PRODUCTS

2.01 WET-PIPE FIRE SUPPRESSION SPRINKLER SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. If manufacturers are listed for the products specified in this Section, subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified and approval by the Program/Project Manager, products from other manufacturers may be provided.
 - 3. Product Options:
 - a. Provide new equipment and system components of the first quality, of the manufacturer's best type, and the latest model capable of complying with the requirements specified in this Section
 - 1) Provide only new and unused equipment, devices, and appliances.
 - 2) Do not provide obsolete equipment.
- B. Description:
 - 1. The Work of this Section consists of providing a combination automatic wet pipe fire sprinkler standpipe system for the 24th Street and RCC Sky Train Stations.
 - a. Furnish the special equipment required for the installation of the Work of this Section and equipment necessary for testing the system.
 - 2. Regulatory Requirements:
 - a. Phoenix Building Construction Code and Phoenix Fire Code:
 - 1) Perform the Work of this Section in compliance with the requirements of the IBC and the IFC.
- C. Design Criteria:
 - 1. General Locations:
 - a. The actual location of the combination wet-pipe fire suppression sprinkler standpipe system equipment, controls, piping, valves, and drains are subject to Program/Project Manager's approval.
 - 2. Deflector Distances:
 - a. Install permanently installed sprinklers so the deflector-to-ceiling distances are in accordance with the requirements specified in NFPA 13.
 - 3. Sprinkler Piping:
 - a. Pipe Sizes:



- 1) For all branch line piping except in gridded systems, provide piping having nominal pipe diameters of at least 1 inch.
 - 2) For all branch line piping in gridded systems, provide piping having nominal pipe diameters of at least 1-1/4 inch.
 - b. Standpipes Connections:
 - 1) Provide standpipe connections calculated in accordance with and designed to comply with the requirements specified in Section 7.10 of NFPA 14 and having City of Phoenix threads.
 - 2) System must be designed to deliver the required flow at a minimum 130 psi at the hose connection.
 - c. Pressure Ratings:
 - 1) Provide fittings having pressure ratings meeting or exceeding the maximum working pressures available within the combination automatic wet-pipe fire suppression sprinkler system.
 - d. Corrosion Protection:
 - 1) Where the piping and hangers are exposed to the weather or installed in a corrosive atmosphere, protect the piping and hangers against corrosion.
 - 2) Provide piping having a corrosion resistance ratio (CRR) greater than or equal to 1.0.
4. Sprinklers:
 - a. Under ducts, stairs, and other obstructions, provide sprinklers in accordance with the requirements specified in NFPA 13.
5. Sprinkler Head Cabinet:
 - a. Locate the sprinkler head cabinet for storing spare sprinkler heads where indicated by the Program/Project Manager.
6. Valves:
 - a. Pressure Ratings:
 - 1) Provide valves having pressure ratings meeting or exceeding the maximum working pressures available within the combination wet-pipe fire suppression sprinkler standpipe system, but rated for not less than 175 psi.
 - b. Supervision:
 - 1) Provide control valves that are locked and electrically supervised.
7. Conflicts Arising Due to Discrepancies between Documents:
 - a. Should conflicts arise due to discrepancies between documents referenced in this Section, the most stringent requirement applies; however, should a level of stringency be indeterminable, resolve the discrepancy as follows:
 - 1) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix, the National Fire Protection Association (NFPA)



- Standards, and this Specification Section take precedence over the Contract Drawings.
- 2) The International Building Code (IBC) as Amended by the City of Phoenix and the International Fire Code (IFC) as Amended by the City of Phoenix take precedence over the National Fire Protection Association (NFPA) Standards, this Specification Section, and the Contract Drawings.
 - 3) The National Fire Protection Association (NFPA) Standards take precedence over this Specification Section and the Contract Drawings.
 - 4) This Specification Section takes precedence over the Contract Drawings.
8. Product Data:
- a. Obtain Product Data, including the original manufacturer's specification sheets, for the products provide as the Work of this Section.
 - 1) Submit the Product Data to the Program/Project Manager for approval.
 - b. Equipment Lists:
 - 1) Submit a Preliminary Equipment List identifying the type, quantity, make, and model number of each piece of combination automatic wet-pipe fire suppression sprinkler standpipe system equipment to be provided under this Contract to the Program/Project Manager for approval.
 - a) Ensure that the types and quantities of equipment on the Preliminary Equipment List coincide with the types and quantities of equipment shown on the Shop Drawings.
 - b) Include the type, quantity, make, and model of spare equipment as specified in this Section.
9. Shop Drawings:
- a. Prepare Shop Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system and the associated equipment and circuits.
 - 1) Include a riser diagram of the system.
 - 2) Indicate the location of the inspector's test and drain valve on the Shop Drawings and riser diagram.
 - b. Prepare Working Drawings for installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system and the associated equipment and circuits in accordance with the applicable codes.
 - c. Submit the Shop Drawings to the Program/Project Manager for approval.



- 1) Do not commence the Work of this Section prior to approval of the Shop Drawings by the Program/Project Manager.
- 2) Changes required in Work installed prior to approval of the Shop Drawings must be performed at no increase in the Contract Price.

10. Calculations.

- a. Have the certified technician holding NICET Level III Fire Protection Engineering Technology Automatic Sprinkler System Layout Certification perform hydraulic calculations for the combination automatic wet-pipe fire suppression sprinkler system:
- b. Submit the calculations to the Program/Project Manager for approval.

D. Materials:

1. Pipe and Fittings:

a. Aboveground Piping Components:

1) 2.0-Inch and Larger Pipe Sizes:

- a) For piping having nominal pipe sizes of 2.0 inches and larger, provide piping complying with the requirements for Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A black steel pipe specified in ASTM A 795/A 795M, except that for nominal pipe sizes of 8 inches (200mm) and greater in diameter Schedule 30 pipe is acceptable; or an equal approved by the Program/Project Manager.

(1) Copper tubing and schedule 40 alternative pipe are unacceptable.

b) Pipe Joints:

- (1) Only provide steel pipes designed to be joined using flanges welded to the pipe or by using mechanical grooved joint systems.

(2) Do not provide pipe designed to be joined by welding or weld fittings.

2) 2.0-Inch and Smaller Pipe Sizes:

- a) For piping having nominal pipe sizes of 2 inches and smaller, provide piping complying with the requirements for Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A steel pipe specified in ASTM A 795/A 795M having threaded end connections; or an equal approved by the Program/Project Manager.

(1) Chlorinated polyvinyl chloride (CPVC) pipe is unacceptable.

b) Fittings:

- (1) Provide fittings complying with the requirements for Class 150 threaded fittings specified in ASME B16.39.

c) Unions:



- (1) Provide unions complying with the requirements for Class 150 unions specified in ASME B16.39.
2. Pipe Hangers and Supports:
 - a. Provide adjustable pipe hangers and supports that are listed in the UL Fire Protection Directory or FM Global Approval Guide.
 - 1) Zinc-plate the rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.
 - 2) Do not mix pipe hanger and support components of different manufacturers.
3. Signs:
 - a. Permanently mark all water supply control valves and drain valves with metal signs that show their function and the sprinkler system zone which they serve.
 - b. Prepare a valve chart to be mounted at the fire alarm control unit (FACU), and submit a copy of the valve chart to the Program/Project Manager for approval.
4. Sprinklers:
 - a. Quick response sprinklers.
 - 1) Inside of the building envelope install ordinary temperature rated sprinklers.
 - 2) Outside of the building envelop install intermediate temperature rated sprinklers.
 - b. Uniformity:
 - 1) Within the same space, only provide sprinklers from the same manufacturer and that each have the same heat response element, including the same temperature rating and response characteristics.
 - c. Corrosion Resistance:
 - 1) For sprinklers located on exterior piping systems, provide corrosion resistant sprinklers.
 - d. Sprinkler Escutcheons:
 - 1) Provide metal escutcheons listed with the sprinklers for recessed sprinkler locations.
5. Supervisory and Alarm Equipment:
 - a. Provide water flow and valve supervisory switches each having 2 "Form C" (DPDT.) contacts for monitoring.
 - 1) Coordinate specific contact ratings with the fire alarm Supplier.
 - b. Water Flow Switches:
 - 1) Provide vane-type water flow indicators capable of indicating the water flow in each sprinkler system zone.
 - c. Supervisory Switches:
 - 1) Provide valve supervisory switches of the loop type, either yoke mounted or integral type.



- 2) Do not provide remote mounted, wire loop type switches.
6. Hose Valve Connections:
 - a. Provide hose valve connections consisting of a 2.5-inch valve having Phoenix type threads.
 - b. Manufacturers:
 - 1) Elkhart Brass, 2.5-inch valve, <http://www.elkhartbrass.com>.
 - 2) Pre-approved equal.
- E. Finishes:
 1. The paint colors and finishes for materials must be approved in writing by the Project/Program Manager.
 - a. The Program/Project Manager will select the finishes for the automatic sprinklers and escutcheons from the manufacturer's standard range.
 - b. The Program/Project Manager will select the finishes for the access panels.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. The Contract Drawings indicate the numbers and prospective locations of system components, including the locations for sprinklers, branch lines, and standpipes and risers.
 2. Review the Contract Drawings, and become familiar with the conditions under which the work will be performed.
- B. Evaluation and Assessment:
 1. If deviations from the approved Shop Drawings are necessary, notify the Program/Project Manager.
 - a. Prior to installation of the deviations, obtain approval in writing from the Program/Project Manager, and subsequent to making the changes update the as-built drawings to reflect the changes.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system.
- B. Demolition/Removal:
 1. Cutting and Patching Openings:



- a. Prior to performing structural Work, submit instructions for furnishing the openings and penetrations required for installing the combination wet-pipe fire suppression sprinkler standpipe system to the Program/Project Manager for approval.
 - 1) Provide any subsequent additional penetrations or openings or relocations required, but not delineated in the original instructions, at no increase in Contract Price.

3.03 INSTALLATION

- A. Prior to installation, ensure that the equipment and materials are clean inside and outside.
 1. Remove all waste material, such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material, from the components before assembly.
 2. Attach pipe coupons or punched holes to the pipe near the pipe hole.
- B. Install the combination automatic wet-pipe fire suppression sprinkler standpipe system's sprinklers and equipment in accordance with the approved Shop Drawings, the limitations of the respective UL listings or FM approvals, and the manufacturer's installation instructions.
 1. Submit the combination automatic wet-pipe fire suppression sprinkler standpipe system manufacturer's written installation instructions to the Program/Project manager for information.
 2. Employ special tools recommended by the manufacturer for installing the system.
 3. Aesthetics is a major consideration when installing sprinklers and sprinkler piping.
 - a. Revise sprinkler installation not meeting with the Program/Project Manager's approval to the satisfaction of the Program/Project Manager.
- C. Exposed Piping:
 1. Remove scale and foreign debris from the system piping.
 2. Minimum Height:
 - a. Install exposed piping and devices as high as possible, but not less than 7-feet 0-inches above the finished floor in traffic or working areas.
 3. Install exposed piping and devices so they do not obstruct any portion of a window, doorway, stairway or passageway; and do not interfere with the operation or accessibility of any mechanical, plumbing or electrical equipment.
 4. Sway Bracing, Flexible Couplings, Hangers:



- a. Design and install the flexible couplings, hangers and sway bracing in accordance with the requirements specified in NFPA 13, including its appendices.
 - 1) Allow for flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structures, so no allowable stresses are exceeded in any member.
 5. Pipe Coatings:
 - a. Paint the piping exposed within the building public areas in accordance with the requirements specified in Section 09912, Painting.
 - b. Prime exterior piping with zinc chromate, and paint the exterior piping in accordance with the requirements specified in Section 09960, High-Performance Coatings.
 - c. Apply the colors selected by the Program/Project Manager.
 6. For all piping 2-1/2 inches and larger in diameter, provide labels at 20-foot intervals to indicate the piping is sprinkler system piping.
- D. Risers:
1. Locate the standpipe for the combination sprinkler standpipe system in the location shown on the Contract Drawings so obstruction of traffic or building operations is minimized.
- E. Sprinklers:
1. Unless otherwise approved by the Program/Project Manager, center sprinklers in finished areas in the center of a ceiling tile plus or minus 2 inches.
- F. Valves:
1. Install valves that control the water supply to the sprinkler systems less than 7-feet 0-inches above the finished floor.
 - a. When specifically approved by the Program/Project Manager, these valves may be installed higher if they are provided with operating chains.
 2. Supervisory Switches:
 - a. Provide valve supervisory switches for all valves controlling the water supply to the sprinkler and standpipe systems, including valves located at backflow preventers.
- G. Expansion Joints
1. Install flexible couplings in accordance with the manufacturer's requirements for the expansion joint locations.
- H. Hose Valve Connections:
1. Provide hose valve connections where shown on the Contract Drawings.



- I. Interface with Other Work:
 - 1. Firestopping:
 - a. Sleeve and grout or seal pipe which passes through fire-resistive barriers, including shaft walls, to maintain the integrity and rating of the fire resistive barrier.
 - b. Provide material for through penetration fire stopping complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems, and that is compatible with the sprinkler piping.
- J. Systems Integration:
 - 1. Cooperation with Other Trades:
 - a. Coordinate installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system with the work of the other trades so construction progresses as rapidly and as smoothly as possible with a minimum of interference between trades.
 - 2. Work that is provided under other Sections but that is related to the combination sprinkler standpipe system includes, but is not limited to, the following:
 - a. Sprinkler Water Flow and Valve Supervisory Switches.
 - 1) Coordinate the connection of the tamper and water flow switches with the fire alarm system installation.
 - 2) Verify the quantity and location of the sprinkler water flow and supervisory switches, and test the switches in accordance with the requirements specified in NFPA 13 and NFPA 72.
 - 3) Devices to be installed under this Section for alarm monitoring of the water flow and valve supervisory switches will be furnished under this Section.

3.04 REPAIR/RESTORATION

- A. Holes:
 - 1. Patch holes made in walls, ceilings, or floors, so the wall, ceiling, floor or member is restored to its original condition, fire resistance, and integrity.
- B. Repair damage to the skins and finishes of the station caused by installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system to the satisfaction of the Program/Project Manager at no increase in Contract Price.
- C. Touch up minor scratches to sprinkler pipe and other accessories using paint and finish techniques matching those originally used on the items.



3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Test Plan:
 - a. Prepare a Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Test Plan describing how the combination automatic wet-pipe fire suppression sprinkler standpipe system will be tested, and include a step-by-step description of all tests and the type and location of the test apparatus to be employed.
 - b. Upon completion of the installation of each system and a minimum of 1 week prior to the Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Pre-Acceptance Test, submit the Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Test Plan to the Program/Project Manager for approval.
 - c. Do not test the combination automatic wet-pipe fire suppression sprinkler standpipe system until the Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Test Plan is approved by the Program/Project Manager.
2. Hydraulic Test:
 - a. Test Procedure:
 - 1) Prior to acceptance of the combination automatic wet-pipe fire suppression sprinkler standpipe system by the Program/Project Manager, flush the system's underground piping, and hydraulically test the system's above ground piping in accordance with the method specified in NFPA 13 and 14.
 - b. Acceptance Criteria:
 - 1) Above ground piping complying with the requirements specified in NFPA 13 passes the Hydraulic Test.

B. Non-Conforming Work

1. Repair or replace nonconforming installation.
2. Do not install system components that are damaged.
3. Do not install system components where there is evidence of manufacturer defects.

3.06 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning; Section 15995, Commissioning of Mechanical Systems; and Section 16995,



Commissioning of Electrical Systems, for the fire protection system Work of this Section.

B. Startup Testing:

1. Prior to the Pre-Acceptance Test, submit 2 copies of the Contractor's Material and Test Certification for above ground piping prepared in accordance with the requirements specified in NFPA 13 and NFPA 14 to the Program/Project Manager for information.
2. After installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system has been completed, the preliminary tests have been completed, and deficiencies found have been corrected, and the system is ready for the Combination Automatic Wet-Pipe Fire Suppression Sprinkler Standpipe System Pre-Acceptance Test, notify the Program/Project Manager in writing a minimum of 2 weeks in advance of this planned demonstration to arrange for the inspection and witnessing of the acceptance tests.
3. Conduct the inspections and witness the acceptance testing.
 - a. This acceptance testing is separate from the testing required by the local Authorities Having Jurisdiction.
 - 1) When local code authorities are required to witness tests, take responsibility for making the necessary arrangements with the code authorities, and for coordinating the work with the Program/Project Manager.
 - 2) Obtain the test documents from the Authorities Having Jurisdiction having the required approval stamps and signatures of the code authorities, and submit a copy of each of these documents to the Program/Project Manager.

C. Pre-Acceptance Test:

1. Perform the tests and inspections required by the referenced Codes and Standards, the Phoenix Fire Department, and the Program/Project Manager.
 - a. Upon completion of each installation phase, perform and document on an approved format, the following combination automatic wet-pipe fire suppression sprinkler standpipe system tests in the presence of the Program/Project Manager or their designed representative:
 - 1) Hydrostatic tests.
 - 2) Test of the sprinkler supervisory system.
 - 3) Flow test from the top standpipe connections.
 - b. Correct any errors, non-conformances, or non-performing components discovered during the Pre-Acceptance Test at no increase in the Contract Price.
2. Final Acceptance Test:



- a. Upon completion of the Pre-Acceptance Test, perform and document in an approved format the following combination automatic wet-pipe fire suppression sprinkler standpipe system tests in the presence of the Program/Project Manager, a designed representative, and the City of Phoenix Authorities Having Jurisdiction:
 - 1) Hydrostatic tests.
 - 2) Test of the sprinkler supervisory system.
 - 3) Flow test from the top standpipe connections.
3. Final Approval:
 - a. Final approval and acceptance of the Work of this Section will only be given by the Program/Project Manager when the following items have been performed to the satisfaction of the Program/Project Manager:
 - 1) The completed combination automatic wet pipe sprinkler and standpipe system has been inspected, tested, and approved by the Program/Project Manager and the City of Phoenix Fire and Development Services Departments.
 - 2) Required submittals, system operation and maintenance manuals, record drawings, completed NFPA 13 and 14 test documents, spare parts, special tools, and training have been provided to, reviewed by, and accepted by the Program/Project Manager.
 - 3) Additional Tests:
 - a) Additional tests required by the referenced codes and standards, design criteria, or in writing by the Program/Project Manager have been satisfactorily performed, and the following information regarding the tests has been submitted to the Program/Project Manager for information:
 - (1) Written directive requiring the additional tests.
 - (2) The date and time each test was performed.
 - (3) A description of each test performed.
 - (4) A checklist of each device tested, indicating the results of each test.
 - (5) A reference set of contractor record drawings, numerically identifying the individual components.

3.07 ADJUSTING

- A. Adjust the fittings and hangars to complete the turn-key fire sprinkler standpipe system installation.
- B. Properly adjust the water flow and valve supervisory switches.



3.08 CLEANING

- A. At the end of the Contract, remove the equipment furnished for testing and flushing, and remove special equipment required for the installation of the Work of this Section.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.
 - 2. When performing flushing and other discharge testing, safely dispose of the water.

3.09 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. To familiarize building personnel with the features, operation, and maintenance of the sprinkler system conduct 2 training sessions of 4 hours each.
 - a. The Program/Project Manager will schedule the training sessions at a time mutually agreeable to the Contractor.
 - b. Final Agenda:
 - 1) Submit the final approved training agenda to the Program/Project Manager 14 days prior to the first training session.
- B. Record Set of Drawings:
 - 1. Prepare a Record Set of Drawings recording the as-built combination automatic wet-pipe fire suppression sprinkler standpipe system in conformance with the requirements specified in the Agreement and Section 01780, Closeout Submittals, to furnish information essential to those who test and maintain the combination automatic wet-pipe fire suppression sprinkler standpipe system and account for all field changes made during installation.
 - a. During installation of the combination automatic wet-pipe fire suppression sprinkler standpipe system, develop a red line Record Set of Drawings that include the original combination automatic wet-pipe fire suppression sprinkler standpipe system Shop Drawings annotated to show exactly where the system components have been installed.
 - b. Furnish floor plans for the Record Set of Drawings showing the as-built information:
 - 2. During the course of the Contract, develop an electronic version of the Record Set of Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system as a draft prepared using software



and electronic media in accordance with the requirements specified in Section 01330, Submittal Procedures.

- a. Show the equipment listed in this Section on a separate layer, and provide copies of this layer only on the floor plans furnished as part of the Record Set of Drawings for the combination automatic wet-pipe fire suppression sprinkler system.
 - b. Update these draft as-built drawings every 24 hours during the installation of each combination automatic wet-pipe fire suppression sprinkler standpipe system.
3. Make the onsite as-built Record Set of Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system available for inspection and review on request by the Program/Project Manager.
 4. Submit the as-built Record Set of Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system as-built drawings to the Program/Project Manager for approval.
 - a. After the combination automatic wet-pipe fire suppression sprinkler standpipe system has been completely installed, and a minimum of 1 week prior to the Combination Automatic Wet-Pipe Fire Suppression Sprinkler System Pre-Acceptance Test, submit an updated, as-built Record Set of Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system on electronic media that complies with the requirements specified in Section 01330, Submittal Procedures, to the Program/Project Manager for approval.
 - b. After the Program/Project Manager approves the as-built Record Sets of Drawings for the combination automatic wet-pipe fire suppression sprinkler standpipe system, they will be posted on Unifier for general distribution.

3.10 PROTECTION

- A. Protect valves and assemblies exposed to potential damage by vehicles or other traffic by providing a cage for the valves and assemblies located inside the building, or guard posts for exterior hydrants and post indicator valves.
- B. For installed piping, valves, devices or accessories which, in the Program/Project Manager's opinion, are subject to physical damage or may be hazards, provide adequate permanent protection
 1. The protective measures to be implemented must be approved by the Program/Project Manager prior to implementation:
- C. To prevent foreign material from entering the piping, furnish caps over openings during and after assembly
 1. For example, pipe caps should be provided on the sprinkler extensions when the pipe is roughed in and the sprinklers are not yet installed.

**3.11 MAINTENANCE****A. Spare Parts List:**

1. Submit a suggested spare parts list of replacement combination automatic wet-pipe fire suppression sprinkler standpipe system parts, with firm unit prices guaranteed to be maintained for the duration of the warranty period as specified herein for the manufacturer's-Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Materials Warranty, to the Program/Project Manager.

B. Maintenance Standard:

1. Furnish and submit a copy of NFPA 25 to the Program/Project Manager.

C. Maintenance Contract:

1. Submit a firm fixed price to furnish a Combination Wet-Pipe Fire Suppression Sprinkler Standpipe System Maintenance Contract for covering a maintenance period of 1 year to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	03/29/2018	N/A	3	Added expansion joint wording to execution section. No cost impact.





SECTION 13941

DOUBLE INTERLOCK PRE-ACTION

FIRE SUPPRESSION SPRINKLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. The new double interlock pre-action fire sprinkler systems (the system). This section describes the requirements for furnishing and installing all materials and labor for the design and installation of new double interlocked pre-action automatic fire sprinkler system, hereafter referred to as the Work (or System). All control valves shall be supervised by the building's fire alarm control unit/releasing control unit (FACU/RCU).
 - a. The system shall be installed to protect the IDF Rooms. Each room shall have a dedicated system as shown in the contract drawings.
2. All work shall be performed in accordance with these specifications. No modifications to these specifications will be accepted without the express written approval of the Program/Project Manager. It is the Contractor's responsibility to document any modifications to the system design prior to the execution of work. Any deviation from these specifications shall be approved in writing, by the Program/Project Manager. All applicable taxes shall be included in the Contractor's base bid.
3. Drawings provided for this work show the general intent for device layout and coverage. These drawings, as such, provide minimum coverage guidelines only. The Contractor shall provide shop drawings in accordance with these specifications, NFPA 13, and all applicable Codes and Standards. Devices installed in public or finished areas shall be fully coordinated with reflected ceiling plans, mechanical, and electrical components as shown on the electrical and mechanical drawings and specifications. The Contractor will be responsible for the development of shop drawings, installation and commissioning of the new double interlock pre-action fire sprinkler systems as required by the City of Phoenix and the Sky Harbor International Airport Aviation Department. These specifications do not necessarily contain all information required for installation of the system, but are intended to be used as a guide by the Contractor for the purpose of shop drawing development and preparing his/her bid.



4. The Contractor shall verify all information contained on the project bid drawings and is responsible for design and installation of the system in accordance with the specifications. If information is not clear, the contractor shall issue an RFI to the Program/Project Manager.
5. At the completion of work, there shall be no degradation of any of the adjoining building system(s) in any way due to the work provided for in this specification.
6. It is intended that the work performed pursuant to these specifications be complete in every respect, resulting in a double interlock pre-action sprinkler system installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations and Underwriters Laboratories Inc. (UL) Listings, and FM Global approval.
7. It is further intended that upon completion of this work, the Program/Project Manager shall be provided with:
 - a. Complete information and drawings describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
 - b. Complete documentation of system testing.
 - c. Certification that the entire system has been inspected and tested, is installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations and UL listings, and is in proper working order. Contractor shall use "Contractor's Material and Test Certificate(s)" as required by Chapter 26 of NFPA 13.
 - d. Copies of required City of Phoenix permits for installation.
8. General: Provide all materials and labor for the design and installation of a new double interlock pre-action sprinkler systems in accordance with the applicable codes and all requirements of this specification.
9. Sprinkler: Provide and install all components necessary for the double interlock pre-action sprinkler systems and provide all monitoring and control points to be interfaced to the fire alarm system, as specified in the Fire Alarm Specification.
10. The Contractor shall perform testing and verify the available water supply at the pre-action riser locations. The Contractor shall submit this documentation with the shop drawings for review and approval by the Program/Project Manager and the City of Phoenix.



11. Waterflow Switches: Provide, install and properly adjust system supervisory switches and waterflow indicators.
12. Drains: Provide indirect piped connections to the exterior of the building necessary to drain and test the double interlock pre-action fire sprinkler system. Coordinate the location with the mechanical drawings.
13. Valves: Provide all supervised control valves, and other appurtenance as required for a fully operable system. All valves are to be electronically supervised.
14. Submittals: Prepare and submit shop drawings, product data sheets, calculations, record drawings and other submittals required herein.
15. Tests: Test the double interlock pre-action sprinkler system. The Contract is required to coordinate acceptance testing with the Fire Alarm Contractor. The Sprinkler Contractor shall be available for troubleshooting during the fire alarm system testing.
16. Warranty: Warranty all new equipment and systems during installation and for a two (2) year period after final acceptance of the work by the Program/Project Manager.
17. Shop Drawings: Develop shop drawings for the review and approval by the Program/Project Manager and City of Phoenix Authorities.
18. Approvals: Obtain all approvals required for the work of this section from the City of Phoenix and from the Program/Project Manager.
19. Fees: Pay all fees required to obtain permits, inspections and final approval of this work.
20. Coordination: Coordinate work with other trades working on the project, and with the other fire protection systems specified elsewhere.
21. Drawings and general provisions of the Contract, including General and Supplementary, apply to this Section.
22. Drawings supplied with this specification shall be used by the Contractor as a reference for the requirement and location of system components. It shall be the responsibility of the Contractor to visit the site, observe the existing conditions, and confirm the required quantities of devices and specific options for locations of the same.
23. Documents, including shop drawings, hydraulic calculations, and water flow test results shall be required for obtaining approval by the Program/Project Manager, the City of Phoenix Fire Department, Sky



Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction (AHJ).

24. Prior to commencement and after completion of work, the Contractor shall provide written notification to the Program/Project Manager.
25. The Contractor shall notify the Program/Project Manager in writing when the system is ready for the Demonstration Test and the Acceptance Test. Notification shall be a minimum of two (2) weeks in advance of the planned tests. The system shall be considered ready for the Demonstration Test, only after all preliminary tests have been made by the Contractor, and all deficiencies have been found and corrected. In addition, two (2) copies of the Contractor's Material and Test Certification for Above Ground shall be submitted to the Program/Project Manager prior to the Demonstration Test.

B. Products Installed but Not Supplied Under This Section:

1. Underground water supply for the fire sprinkler system.

C. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01780 - Closeout Submittals.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. National Fire Protection Association (NFPA)
2. International Fire Code (IFC)
3. International Building Code (IBC)
4. Underwriters Laboratory (UL)
5. Fire Alarm Control Unit (FACU)
6. Releasing Control Unit (RCU)

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:



1. City of Phoenix (COP):
 - a. International Building Code (IBC) – 2012 with City of Phoenix amendments.
 - b. International Fire Code (IFC) – 2012 with City of Phoenix amendments.
2. The fire sprinkler system shall comply with all applicable codes and standards, including the International Building Code (IBC) – 2012 with City of Phoenix amendments, the International Fire Code (IFC) – 2012 with City of Phoenix amendments, and NFPA 13 – 2013.
3. All equipment and devices shall be labeled and Listed for the intended use in Underwriters Laboratories, Inc. (UL), UL FPED *Fire Protection Equipment Directory*.
4. If a UL Listing for a specific device is unavailable, approval by FM Global (FM) or other nationally recognized testing laboratory (NRTL) acceptable to the Program/Project Manager.
5. Installation shall be made in accordance with the applicable provisions of the following:
 - a. NFPA 70 – (2011) National Electrical Code® (NEC) as amended by the City of Phoenix.
 - b. NFPA 72 – (2013) National Fire Alarm and Signaling Code.
 - c. NFPA 13 – (2013) Standard for the Installation of Sprinkler Systems.
6. The latest published edition of the equipment manufacturers' product datasheets, technical specifications, installation instructions and wiring guidelines.
7. The systems shall be tested in accordance with the following:
 - a. NFPA 13 – 2013 Chapter 26, Installation of Sprinkler Systems.
 - b. The latest published edition of the equipment manufacturers' testing procedures and guidelines.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Prior to commencement and after completion of the Work of this Section, provide written notification to the Program/Project Manager.



2. Coordinate with the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
3. Coordinate the installation and testing of the system and the associated equipment and circuits with the appropriate Subcontractors, equipment maintenance and testing representatives, the Sky Harbor International Airport Aviation Department, and the Authorities Having Jurisdiction (AHJ).
 - a. Coordinate the System Pre-Acceptance and the Final Acceptance Test of the system specified herein with the Program/Project Manager, the Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction (AHJ).
 - 1) At the time of notification, submit 1 copy of the approved Record Set of Drawings and the approved System Test Plan to the Program/Project Manager.
 - b. Final Acceptance Test:
 - 1) In order to assure attendance at the Final Acceptance Test by the necessary representatives, provide reasonable notification of the test date to each representative scheduled to witness the test at least 48 hours prior to the test.
 - 2) Do not conduct this test until all parties agree on a test date.
4. Coordinate the networking of the system releasing panels to the new FACU.
5. Coordinate the dates and times of each required training session as specified herein through the Sky Harbor International Airport Aviation Department, not less than 2 weeks prior to the training session.
6. Conflicts Arising Due to Discrepancies between Documents:
 - a. Should conflicts arise due to discrepancies between documents referenced in this Section, the most stringent requirement applies; however, should a level of stringency be indeterminable, resolve the discrepancy as follows:
 - 1) The International Building Code (IBC), the International Fire Code (IFC), the National Fire Protection Association (NFPA) Standards, this Section shall take precedence over the Contract Drawings.



- 2) The International Building Code (IBC) and the International Fire Code (IFC) take precedence over the National Fire Protection Association (NFPA) Standards, this Section, and the Contract Drawings.
- 3) The National Fire Protection Association (NFPA) Standards shall take precedence over, this Section, and the Contract Drawings.
- 4) This Section takes precedence over the Contract Drawings.

B. Sequencing:

1. Complete all component installation, and coordination of wiring, circuit testing in time so the fire alarm equipment Supplier can make the final connections and conduct tests of the fire alarm system as specified other sections without delaying the Work.

C. Scheduling:

1. Prior to beginning the Work of this Section, submit a schedule indicating the system installation sequence and time frame to the Program/Project Manager for approval.
 - a. Include specific time lines indicating the start and completion of major portions of the system installation.
 - b. Indicate the delivery dates of the equipment to be supplied.
 - c. Indicate the dates for the system Pre-Acceptance and the Final Acceptance Test specified herein.
2. Provide weekly schedule updates to the Program/Project Manager for approval.
3. Advise the Program/Project Manager of all anticipated projects the Contractor and the equipment supplier may have with the same approximate completion date as this contract, and what impact those projects may have on the timely completion of this contract.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Densities: Hydraulically calculated sprinkler systems shall be installed in accordance with the construction documents. The systems have been designed to produce discharge densities of:



- a. 0.15 gpm/square foot over the hydraulically most remote 1,950 (Ordinary Hazard).
2. Develop and submit shop drawings.
3. Hose stream requirements: The calculations shall include a 100 gpm inside hose stream. The combined (inside and outside) hose stream for the calculations shall be 250 gpm located at the base of the riser.
4. Sprinklers under ducts (or other): Provide sprinklers under ducts and obstructions as required by NFPA 13.
5. All branch line piping shall be 1" minimum.
6. All hydraulically calculated sprinkler systems shall provide a minimum safety factor of 10 percent between the calculated sprinkler system demand and the available water supply.
7. Separate area control valve assemblies shall be provided for the pre-action sprinkler system.
8. Water supply information shall be obtained from the local water authority where the project is located. The Contractor is required to calculate pressure losses due to elevation and friction through all fittings, piping, and valves in accordance with NFPA 13.
9. The pre-action system shall be designed so that opening of the inspector's test connection with normal supervisory air pressure in the piping simultaneously with electrical tripping of the valve shall deliver water to the inspector's test connection within 60 seconds.
10. Sprinkler heads shall be on return bends or dry pendent sprinklers shall be provided on all drops.

1.05 SUBMITTALS

A. Informational Submittals:

- a. Prior to performing any work, submit the following Contractor documentation in addition to those documents required elsewhere in this specification.
- b. Written confirmation of how the manufacturer/supplier plans to comply with the performance operational design of the system and all pertinent information regarding the reliability and operation of the equipment to be supplied.

B. Maintenance Material Submittals:



1. Provide per unit costs for additional devices and appliances to the Program/Project Manager with firm prices maintained for one year beyond the duration of the manufacturer's warranty period as specified herein.

C. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) The Contractor shall submit a product data submittal with the shop drawings. Manufacturer's Data Sheets shall show the type and model of all equipment or material proposed. This information shall include type of pipe or tube, hangers, valves, pipe fittings/joining methods, air compressors, sprinklers, escutcheons, and signage. When a Data Sheet shows more than one product, the specific proposed product shall be clearly indicated by arrows or other suitable means
 - b. Certificates:
 - 1) Project supervisor NICET II certificate.
 - 2) Shop drawing technician NICET III or IV certificate.
 - c. Shop Drawings:
 - 1) Shop Drawings: The Contractor will be authorized to start each portion of the work when the shop drawings are received, reviewed and approved by the Program/Project Manager and the City of Phoenix. Installation prior to these approvals shall be at the risk of the Contractor.
 - 2) Submit the system shop drawings for review and approval to the Program/Project Manager.
 - 3) Submit the system shop drawings for review and approval to the City of Phoenix Annual Facilities Program (AFP).
 - 4) Shop drawings shall show all of the information required by NFPA 13 for working plans and shall include drawings showing the location of all equipment, controls, piping, valves and drains. The drawings shall also show: Locations of all sway bracing, seismic bracing, hangers and of flexible couplings installed as flexure joints, location and diameter of all necessary core drills, pipe sleeves and pipe clearance openings in walls and floors.



2. Contractor shall provide hydraulic calculations to show that the pipe sizes provided will produce adequate performance.
3. The Program/Project Manager shall review and recommend approval/disapproval or take other appropriate action on the Contractor's submittals including shop drawings, samples, documentation and record drawings. This review is to verify conformance to project specifications and design concepts expressed in the Contract Documents. This action shall be taken with all reasonable promptness as to cause no delay in the work, while allowing sufficient time to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details (e.g., dimensions) or for substantiating installation or performance of equipment or systems designed by the Contractor, all of which remain the Contractor's responsibility to the extent required by the Contract Documents. The Program/Project Manager's review shall not constitute approval of safety precautions for construction, means, methods, techniques, sequences of procedures or approval of a specific assembly of which the item is a part.
4. If submittals are found not to conform to the requirements of these specifications; the Contractor shall be required to resubmit with modifications within 5 calendar days. The Contractor shall be responsible for the expenses for subsequent review(s) of rejected submittals necessitated by the Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments to the Contractor. Approval of the submittals shall, in no case, relieve the Contractor of his responsibility to meet the requirements of this specification.
5. The Program/Project Manager shall review all submittals prior to submittal to local authorities for review and approval.
6. All drawings and diagrams shall be prepared on drawing sheets of uniform size, in accordance with the governing CAD Specifications for the project and shall contain no extraneous information. Marked up electrical, HVAC, or similar drawings or copies of catalog data sheets are not acceptable in lieu of the required drawings or diagrams. All other information required for this submittal shall be submitted in one or more appropriately labeled (i.e., Contractor's name, project, submittal name/description and date) and indexed 3-ring binders.
7. All drawings and diagrams shall include the Contractor's title block, complete with drawing title, Contractor's name, address, date including revisions, and preparer's and reviewers' initials.



8. Floor plan drawings required for this submittal may be generated using the bid drawings as backgrounds.
9. Samples: Upon award of the change order and within 5 business days of authorization to proceed, the Contractor shall submit to the Program/Project Manager for approval samples of all types of proposed equipment list including sprinklers and types of finishes available and a complete list of where each type and finish will be installed.
10. Permits: Prior to start of installation, the Contractor shall submit copies of all permits and approvals to the Program/Project Manager necessary to conduct this work.
11. Certificates: The Contractor shall provide the Program/Project Manager with one copy of all documents that are reviewed and approved by the local code authorities. These documents shall include, but not be limited to, the following:
 - a. Site inspection forms
 - b. Shop drawings
 - c. Final inspection forms
 - d. Service directory – submit to the Program/Project Manager the draft O & M manual for approval (excluding the test certificates and drawings, and final Operation & Maintenance manual upon completion of the work
12. All documents shall include all required approval stamps, signatures or other information necessary to properly certify that the installation has been reviewed and accepted by the Program/Project Manager and the City of Phoenix Development Services, Aviation, and Fire Departments.
13. Operation and Maintenance Manual: The Contractor shall provide the Program/Project Manager with a loose-leaf manual containing:
 - a. 11" x 17" reduced copies of the record drawings required below (Final submittal only)
 - b. Manufacturer's catalog data sheets and installation manuals
 - c. A detailed narrative description of the system architecture, inputs, evacuation signaling, auxiliary functions, suppression system releasing, annunciation, intended sequence of operations, expansion capability, application considerations and limitations.



- d. Operator instructions for basic system operations including alarm acknowledgement, system shutdown, system reset, operation of controls, isolation of components for servicing, etc.
 - e. Copy of NFPA 25.
 - f. Copy of all test certificates and approvals.
 - g. A list of recommended spare parts.
 - h. A service directory, including a list of individual's names and telephone numbers to obtain service on the system, including emergency service as required elsewhere in these Specifications.
 - i. Final O&M Manual: Within 30 days of the completion of the work, copies of the approved manual with reduced drawings and test certificates shall be delivered to the Owner.
 - j. Record Drawings: The Contractor shall provide and maintain on the site an up-to-date record set of City of Phoenix approved shop drawing prints which shall be red line marked to show each and every change made to the double interlock pre-action sprinkler system from the original approved shop drawings. This shall not be construed as authorization to deviate from or make changes to the shop drawings approved by the Program/Project Manager without written instruction in each case. This set of drawings shall be used only as a record set. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours.
14. Final Submittal: Upon review of the record drawings, before final approval, one set of reproducible record drawings and two additional sets of bond record drawings shall be delivered to the Program/Project Manager in accordance with the project CAD specifications.
15. If the Contractor's submittals, upon review by the Program/Project Manager do not conform to the requirements of these specifications, the Contractor shall be required to resubmit with modifications, within five (5) working days of receipt of the Program/Project Manager's notification to the Contractor. The Contractor shall be responsible for the Program/Project Manager's extra expenses for subsequent review of rejected submittals necessitated by the Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments by the Program/Project Manager to the Contractor.

D. Closeout Submittals:



1. Submit the following to the Construction Manager in accordance with the requirements of Section 01780, Closeout Submittals:

- a. Warranty Documentation:

- 1) Transmit to the Program/Project Manager all applicable warranty information about the installed materials and products.

E. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

- a. Spare Parts:

- 1) Spare parts and special tools shall be provided to the Program/Project Manager prior to final acceptance, and be provided for each building.
 - 2) Spare Parts: The Contractor shall install one metal sprinkler cabinet containing a minimum total of five sprinklers, of each type, finish and temperature rating used. Contractor shall provide two (2) sets of sprinkler wrenches compatible with each type of sprinkler provided. The cabinets shall be installed at the locations approved by the Program/Project Manager.
 - 3) The Contractor shall provide at least five working days' notice for all tests.
 - 4) All Contractor's testing shall conform minimally to the applicable requirements NFPA 13 Chapter 26. Contractor testing shall include 100 percent of all devices, appliances, interfaced systems and control unit functions. The Contractor shall record the results of the tests.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. All Contractors connected with the captioned project shall provide proof of competence of both their company and the individual foreman that will be assigned to this project. The Contractor shall have been in the business of installing fire sprinkler systems for at least five (5) years, acceptable to the Program/Project Manager. Once assigned, the Contractor's foreman shall not be changed without the approval of the Program/Project Manager.



2. If the use of outside sub-contractors is necessary, the sub-contractor shall be licensed in the State of Arizona and be experienced in the installation of systems in buildings similar to the building in question and has obtained design and inspection approvals for similar projects from Authorities Having Jurisdiction.
3. Each proposed bid shall be professionally presented, bound and shall include a title page and index.
4. As a minimum, all bidding Contractors shall include the following in the fire sprinkler systems bid:
 - a. The names and qualifications of the Contractor's and the equipment supplier's foreman and project manager during the entire project installation. Contractor's and supplier's qualifications shall include years in business, service policies, warranty definitions and prior experience with installations that include the type of equipment that is to be supplied.
 - b. The personnel and company contact information of all subcontractors that the Contractor plans to use on this project.
 - c. A list of at least three (3) similar installations with addresses of properties, contact names, telephone numbers, and types of system equipment installed.
 - d. The price for the systems as specified, the prices for required and recommended or requested alternatives for equipment, service work not included in the warranty and prices for a service contract. The Contractor shall list all deviations and/or exceptions to these specifications as proposed alternatives.
 - e. Completed pricing shall be accompanied by equipment manufacturer's product data sheets for the major components of the proposed system.
 - f. Nonconformance to the Qualification of Bidders requirements outlined in this specification shall be cause for immediate dismissal of the Bid Documents without comment.
 - g. The award of the contract shall be based on the submitted information and all considerations in the best interests of the Program/Project Manager. Once the contract is awarded, no requested changes for equipment, suppliers or subcontractors shall be accepted unless justification is made in writing. Once assigned, the Contractor's foreman and the fire sprinkler technicians shall not be changed



without the approval of the Program/Project Manager. Upon written request from the Contractor, the Program/Project Manager may authorize changes, but at their sole choice and discretion. The Contractor shall be at risk for any attempt to substitute the equipment suppliers or subcontractors accepted. All cost for removal, relocation, or replacement of a substituted item shall be at the risk of the Contractor.

B. Order of Precedence:

1. Should conflicts arise out of discrepancies between documents referenced in this specification, the most stringent requirement shall apply; however, should a level of stringency be indeterminable, the discrepancies shall be resolved as follows:
 - a. The Phoenix Sky Harbor International Airport Sky Train Project Design Manual shall take precedence over this specification.
 - b. The IBC and IFC shall take precedence over this specification.
 - c. The National Fire Protection Association Standards shall take precedence over this specification.
 - d. This specification shall take precedence over the drawings.
2. System Technical Representative's Qualifications:
 - a. To supervise the field installation of the system provided under this Contract, employ a trained and qualified technical representative who, at a minimum, holds a current NICET Level II Fire Protection Engineering Technology Water Based Sprinkler Design Certification.
 - b. Submit the name and qualifications of the proposed system technical representative who will be in responsible charge of the installation of the system under this Contract to the Program/Project Manager for approval.
 - c. Do not replace an approved system technical representative without the written approval of the Program/Project Manager.
 - d. The specified system Shop Drawings and calculations shall be prepared by a certified technician holding at a minimum NICET Level III Fire Protection Engineering Technology Water Based Sprinkler Design Certification or licensed Fire Protection Engineer in the State of Arizona.



3. Sufficient information to describe their qualifications, the work efforts to be performed, and the materials to be provided, including the names and qualifications of the Contractor's and the equipment Supplier's Project Manager who shall be in responsible charge during the entire project installation.
4. Drawings supplied with this specification shall be used by the Contractor as a reference for the requirement and location of system components. It shall be the responsibility of the Contractor to visit the site, observe the existing conditions, and confirm the required quantities of devices and specific options for locations of the same.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. The Sprinkler Contractor shall store all fire suppression system equipment in accordance with the manufacturer's specifications.

1.08 WARRANTY

A. Manufacturer Warranty:

1. The Contractor shall warrant all materials and workmanship for a period of two (2) years beginning with the date of final acceptance by the Program/Project Manager. The Contractor is responsible during the design, installation, testing and guarantee periods for any damage caused by him (or his subcontractors) or by defects in his (or his subcontractors') work, materials, or equipment.

B. Special Warranty:

1. During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by the Owner or owner for such service. This service shall be provided on a 24-hour per day, seven days per week basis.

PART 2 PRODUCTS

2.01 CONTRACTOR-FURNISHED PRODUCTS

A. New Products:

1. All equipment and system components furnished and installed shall be new and of first quality, and be listed by Underwriters Laboratories Inc. (UL), or approved by Factory Mutual (FM) for their intended use. All such



equipment and system components shall be installed within the limitations of the respective UL listings or FM approvals.

2. The double interlock pre-action deluge valve shall be quick opening, hydraulically operated and controlled with a diaphragm deluge valve mechanism and hydraulic lock open using a pressure relief operated valve. The actuating device shall be controlled by an electrically actuated hydraulic releasing device. Closing of the main water supply valve and manually closing the hydraulic control line shall automatically reset the diaphragm deluge valve. Valve shall be released either manually at the valve or automatically from the Pre-Action Fire Alarm Control Panel. Valve shall be complete with all trim piping and devices including sprinkler riser, air compressor with an air maintenance device for supervision of piping, with flow alarm, valve and air supervisory pressure switches.

B. Pipe and Fittings – General:

- a. Pressure ratings: Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.
 - b. Corrosion protection: All piping and hangers where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion
 - c. All piping shall have a corrosion resistance rating ratio (CRR) greater than or equal to 1.0.
 - d. Fire Department Connections: Furnish new.
2. Aboveground Piping Components:
- a. Pipe Sizes 2 inches and Larger: Steel pipe shall be ASTM A 795, Weight Class STD (Standard), Schedule 40 Type E or Type S, Grade A; black steel pipe or approved equal. Steel pipe shall be joined by means of flanges welded to the pipe or mechanical grooved joints only. Piping shall not be joined by welding or weld fittings.
 - b. Piping Sizes 2 inches and smaller: Steel pipe shall be ASTM A 795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, steel pipe with threaded end connections or approved equal. Fittings shall be ASME B16.39, Class 150, threaded fittings. Unions shall be ASME B16.39, Class 150, unions
 - c. Chlorinated polyvinyl chloride (CPVC) Pipe is not permitted.
 - d. Copper pipe or tube or schedule 40 equivalent pipe are not permitted.



- e. Pipe hangers and supports: Pipe hangers and support shall be listed in the UL Fire Protection Directory or FM Global Approval Guide and shall be the adjustable type. Finish of rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication. They shall be according to the manufacturers listing. Mixing of components between manufacturers is not permitted.
3. Control and Drain Valves:
- a. Types: Sprinkler system control and drain valves shall be the following types:
 - 1) O.S&Y. gate valves
 - b. Butterfly valves that are approved for use in sprinkler systems.
 - c. Butterfly valves with integral valve supervisory switches that the entire assembly is approved for use in sprinkler systems.
 - d. Listing: All valves shall be UL listed or FM approved for their intended use.
 - e. Signs: All water supply control valves and drain valves shall be permanently marked with metal signs to show their function and sprinkler system zone which they serve. Provide a valve chart to be mounted at the FACU.
 - f. Pressure Ratings: Pressure ratings of all valves shall meet or exceed maximum working pressures available within the system. A minimum 175 psi is required.
 - g. Supervision: All control valves shall be and electrically supervised.
 - h. Access Panels: Provide and install access panels (minimum size 12-inches by 12-inches) for all control valves located above finished ceilings or concealed in walls. Owner will select finish of access panels. Access panels installed in fire resistive construction shall be of the types required for maintaining proper protection of assembly.
 - i. Valves and assemblies that are exposed to potential damage by vehicles or other traffic are to be protected by providing a cage when located inside the building, or guard posts for exterior hydrants and post indicator valves.
4. Specialty Valves
- a. Deluge Valves: UL Listed, 250-psig working pressure, 90-degree or straight-through pattern, designed for horizontal or vertical installation,



externally resettable by hydraulic means, positive priming line vent, cast-iron flanged or grooved inlet and outlet, complete with compatible trim set.

- b. Solenoid Valve: UL Listed, 250-psig working pressure, electrically operated, ½-inch brass body with stainless steel core tube, core, plug nut and springs.
 - c. The Contractor shall furnish and install an air check valve on the riser as recommended by the Pre-Action Valve's manufacturer.
 - d. Deluge, Solenoid and Control Valves for the pre-action system shall be manufactured by Reliable Automatic Sprinkler Company or pre-approved equal.
5. Sprinklers:
- a. Types: Quick Response, 165 degree Fahrenheit unless otherwise noted in the contract drawings.
 - b. Final Selection: The Program/Project Manager will select finishes for all automatic sprinklers and escutcheons.
 - c. Uniformity: All sprinklers within a space shall be from the same manufacturer and have the same heat response element, including temperature rating and response characteristics.
 - d. Corrosion Resistance: Sprinklers located on exterior piping systems shall be corrosion resistant.
 - e. Sprinkler Escutcheons: Escutcheons shall be metal and be listed with the sprinklers for recessed sprinkler locations.
 - f. Sprinkler Orifice: All sprinklers shall be standard orifice sprinklers (1/2" orifice) unless specifically approved otherwise.
 - g. All sprinklers in finished areas shall be center of tile plus or minus 2 inches, unless approved by the Owner.
 - h. Listed sprinkler guards shall be installed where heads are positioned at or less than 7-feet above the finished floor.
6. Identification Signs:
- a. Contractor shall furnish and install hydraulic calculation signs for each new sprinkler zone. Contractor shall also provide identification signs for all valves installed under this section.



- b. Required Information: Hydraulic calculation signs shall include all information indicated in Appendix A, NFPA 13. Valve identification signs shall identify the function of the valve and the area served.
 - c. Description: Signs shall be rigid, flat steel or aluminum plaques with embossed enamel background and lettering. Signs shall be secured by chain or durable wire to each sprinkler zone control valve, or in an obvious location specifically approved by the Owner.
 - d. The hydraulic calculation signs shall be installed in a workmanlike manner on the riser of each system.
7. Supervisory and Alarm Equipment:
- a. All waterflow and valve supervisory switches shall be furnished, installed and properly adjusted by this Contractor. Alarm monitoring of these devices will be by others.
 - b. Contacts: All waterflow and valve supervisory switches shall be provided with two "Form C" (D.P.D.T.) contacts for monitoring. Specific contact rating shall be coordinated with the fire alarm Contractor.
 - c. Waterflow Switches: pressure type waterflow indicators shall be provided to indicate waterflow in each sprinkler system zone.
 - d. Supervisory Switches: Valve supervisory switches shall be provided for all valves controlling the water supply to the sprinkler and standpipe systems.
 - e. Loop Type Switches: Valve supervisory switches shall be the yoke mounted or integral type. Contractor shall not use remote mounted, wire loop type switches.
8. Inspector's Test and Drain Assembly:
- a. An inspector's test and drain assembly is required.
 - 1) Test and drain assembly(s) shall be provided for the double interlock pre-action system. This test and drain assembly shall be a modular unit type. The valve location shall be located on the shop drawings and riser diagram.
 - 2) An inspector's test and drain assembly shall be provided at the most hydraulically remote part of the double interlock pre-action system shall discharge to a location approved by the Program/Project Manager and as shown on the contract drawings.



- 3) Inspector's test and drain assemblies shall comply with the requirements of NFPA 13. All components of test and drain assemblies shall be UL listed or FM approved.
- 4) Discharge: All test connections and drain riser connections shall be hard piped to discharge waste water to the exterior of the building. The sprinkler contractor shall coordinate routing of the drain pipe with the mechanical drawings.

9. Risers:

- a. Supervisory Switches: Valve supervisory switches shall be provided on all valves controlling water supply to the fire sprinkler system, including valves located at backflow preventers.
- b. All flexible couplings, hangers and sway bracing shall be designed and installed as required by NFPA 13 (including all appendices). Flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure(s) shall be allowed for, so that no allowable stress is exceeded in any member.

10. Pressure Gauges

- a. Pressure gages shall be UL Listed (UL 393), 3-1/2- to 4-1/2-inch-diameter dial with dial range of 0 to 250 psig.

11. Automatic Air Pressure Maintenance Device

- a. UL Listed, FM approved, automatic air pressure maintenance device to maintain a constant air pressure within the pre-action sprinkler piping is required.
- b. The automatic air pressure maintenance device shall be constructed of non-corrosive material, and consist of the following:
 - 1) Adjustable sensing element for sensing of the air pressure within the pipe and for activation of the flow control device.
 - 2) Flow control device to limit the flow of air into the system.
 - 3) Backflow prevention device to prevent the flow of air out of the sprinkler system.
 - 4) Strainer sized to protect the flow control device.
 - 5) Valved, 1/4 inch air supply bypass around the flow control device.

12. Compressed Air Supply



- a. Provide air supply capable of restoring system pressure within 30 minutes. Acceptable air supply arrangements are:
 - 1) A riser mounted air compressor with an air pressure maintenance device between the air compressor and the air supply inlet on the system riser.
 - 2) A riser mounted air compressor feeding an air reservoir with an air pressure maintenance device placed between the air reservoir and the system riser.
 - 3) A riser mounted compressor listed as an air maintenance compressor.

13. Releasing Control Unit (RCU)

- a. Provide an RCU for each of the double interlock pre-action fire sprinkler systems.
- b. The RCU shall be conventional or analog addressable.
- c. The RCU shall be compatible and networked with the Honeywell Fire Alarm Control Unit.
- d. The RCU shall be capable of processing the signals from the fire detection devices and air loss for the actuation of the deluge valve.
- e. The control unit shall support a minimum of two (2) visible (strobe) and two (2) audible notification appliance circuits to provide an evenly distributed number of notification appliances. All visible (strobe) notification appliance circuits shall be independent from the audible notification appliance circuits. Each circuit's power load shall not exceed 75% of the individual circuit power available from the RCU and new installed circuits shall be Class A (Style Z) circuits. Additional NACs shall be furnished and installed as necessary to comply with this requirement.
- f. Power for all notification appliances shall come from integral power supplies in the RCU. Remote power supplies, if needed, shall be of the same manufacturer as the RCU. The location of all remote control equipment, such as remote power supplies (extenders) shall be approved prior to installation by the Program/Project Manager.
- g. RCU shall be manufactured by Honeywell, Notifier, FCI-Gamewell, Potter or pre-approved equal.

C. Manufacturers:



1. Manufacturer List:
 - a. All equipment and system components furnished and installed shall be new and of first quality, and be listed by Underwriters Laboratories Inc. (UL), or approved by Factory Mutual (FM) for their intended use. All such equipment and system components shall be installed within the limitations of the respective UL listings or FM approvals.
2. Substitution Limitations:
 - a. Only approved in writing by the Program/Project Manager.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. It shall be the Contractor's responsibility to inspect the drawings and become familiar with the conditions under which the work will be performed.
 2. Cooperation with other trades: The sprinkler Contractor shall coordinate with the work of the other trades towards the general purpose of having the construction progress as rapidly and as smoothly as possible with a minimum of interference between trades.
 3. Openings, cutting and patching: Before the start of Structural Work, the sprinkler Contractor shall submit instructions for openings and penetrations required for his work to the Program/Project Manager. Instructions shall be subject to the Program/Project Manager's approval. The Contractor shall provide any subsequent additional penetrations, openings, or relocation required, but not delineated in his instructions at no additional cost to the Program/Project Manager.
 4. Approval prior to installation: No work shall commence prior to approval of shop drawings by the Program/Project Manager. Any change in work which has been installed prior to approval of the shop drawings shall be made without additional compensation to the Contractor.
 5. All materials will be stored in a proper manner, so they are not subject to damage, moisture, or other reasonable unforeseen circumstances.

3.02 PREPARATION

- A. Protection of In-Place Conditions:



1. Aesthetics shall be a primary consideration when installing sprinklers and sprinkler piping. Any facet of sprinkler installation that does not meet with the Program/Project Manager's approval shall be revised by the Contractor.
2. Holes: All holes made by the Contractor in any wall, ceiling, or floor shall be patched by the Contractor, restoring the wall, ceiling, floor or member to its original condition, fire resistance, and integrity.
3. General Locations: Location of all equipment, controls, piping, valves and drains shall be subject to Owner's approval.
4. Special Installation Instructions: All sprinklers and equipment shall be installed in accordance with manufacturer's instructions. All special tools recommended by the manufacturer shall be used.
5. Deflector Distances: Sprinklers permanently installed shall be installed with the deflector to ceiling distances in accordance with NFPA 13.

3.03 INSTALLATION

1. The system shall be installed in accordance with the approved shop drawings. If deviations are necessary, the Program/Project Manager shall be notified prior to installation. Approval shall be obtained in writing from the Program/Project Manager and the as-built drawings updated to reflect the change.
2. Sprinkler piping on any floor level may cross building structural separations such as expansion and seismic joints, provided that the piping is specifically designed with flexible connections at each crossing and able to accommodate the calculated differential motions during an earthquake in accordance with the IBC and NFPA 13. All required structural, differential movement and drift calculations shall be prepared by a licensed structural engineer possessing current State of Arizona Registration. (Contractor shall verify locations of seismic joints.).
3. All sprinkler piping installed in public areas or non-public areas with suspended ceilings shall be concealed in the walls, ceilings. Pipe in unfinished areas may be exposed.
4. Exposed Piping: All piping exposed within the building public areas shall be painted by the Contractor. All exterior piping shall be primed with zinc chromate and painted by the Contractor. Program/Project Manager to select paint colors.
5. Escutcheon Plates: All exposed pipe which passes through a wall, ceiling, or floor shall be provided with escutcheon plates.



6. Minimum Height: All exposed piping and devices shall be installed as high as possible, but no less than 7-feet 0-inches above the finished floor in traffic or working areas, and so as not to obstruct any portion of a window, doorway, stairway or passageway, and shall not interfere with the operation or accessibility of any mechanical, plumbing or electrical equipment.
7. Operating Chains: Valves controlling water supply to the sprinkler systems shall be less than 7-feet 0-inches above the finished floor when specifically approved by the Program/Project Manager. They may be higher if they are provided with operating chains.
8. Protection: The Contractor shall provide Program/Project Manager approved permanent protection for any installed piping, valves, devices or accessories which, in the Program/Project Manager's opinion, are subject to physical damage or may be hazards.
9. Firestopping: Pipe which passes through fire-resistive barriers shall be sleeved and grouted or sealed to maintain the integrity and rating of the fire resistive barrier. Material used for through penetration fire stopping shall be compatible with the sprinkler piping.
10. Testing: All piping is to be flushed and hydraulically tested prior to acceptance by Program/Project Manager. Flushing and testing shall be performed in accordance with NFPA 13. Above ground piping is not permitted to lose any pressure during the tests.
11. Contractor shall provide all equipment necessary for testing and flushing and any special equipment required for the installation of any portion of the specification and drawings. The Contractor is also responsible for removing all same equipment at the end of the job.
12. All piping 2-1/2" and larger shall be provided with labels at 20-foot intervals indicating sprinkler system piping.

B. Sway Bracing, Flexible Couplings, Hangers

1. All flexible couplings, hangers and sway bracing shall be designed and installed as required by NFPA 13 (including all appendices). Flexibility, internal pressure, and differential movement between the piping and building, earth, or other supporting structure(s) shall be allowed for, so that no allowable stress is exceeded in any member.

C. Interface with Other Work:



1. Cooperation with other trades: The sprinkler Contractor shall coordinate with the work of the other trades towards the general purpose of having the construction progress as rapidly and as smoothly as possible with a minimum of interference between trades.
2. Openings, cutting and patching: Before the start of Structural Work, the sprinkler Contractor shall submit instructions for openings and penetrations required for his work to the Program/Project Manager. Instructions shall be subject to the Program/Project Manager's approval. The Contractor shall provide any subsequent additional penetrations or openings or relocation required, but not delineated in his instructions at no additional cost to the Program/Project Manager.
3. Approval prior to installation: No work shall commence prior to approval of shop drawings by the Program/Project Manager. Any change in work which has been installed prior to approval of the shop drawings shall be made without additional compensation to the Contractor.

3.04 SYSTEM STARTUP

- A. Documents, including shop drawings, hydraulic calculations, and water flow test results shall be required for obtaining approval by the Program/Project Manager, the City of Phoenix Fire Department, Sky Harbor International Airport Aviation Department, and other authorities having jurisdiction.
- B. Prior to commencement and after completion of work, the Contractor shall provide written notification to the Program/Project Manager.
- C. The Contractor shall notify the Program/Project Manager in writing when the system is ready for the Demonstration Test and the Acceptance Test. Notification shall be a minimum of two (2) weeks in advance of the planned tests. The system shall be considered ready for the Demonstration Test, only after all preliminary tests have been made by the Contractor, and all deficiencies have been found and corrected. In addition, two (2) copies of the Contractor's Material and Test Certification for Above Ground Piping from NFPA 13 shall be submitted to the Program/Project Manager prior to the Demonstration Test.

3.05 CLEANING

- A. All equipment and materials prior to installation shall be clean inside and outside. All waste material such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material shall be removed from the components before assembly. All pipe coupons or punched holes shall be attached to the



pipe near the pipe hole. Caps shall be located over openings even during and after assembly to prevent foreign material from entering the pipe at any time. For example, pipe caps should be provided on all sprinkler extensions even when pipe is roughed in and sprinklers are not yet installed.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration:

1. The Contractor shall make arrangements with the Program/Project Manager for final inspection and witnessing of the final acceptance tests. The Contractor will conduct the final inspection and witness the final acceptance test. This test shall be separate from testing by the local authorities. A full trip test of the deluge valve is required.
2. Required Tests: All tests and inspections required by the referenced Codes and Standards, the Phoenix Fire Department, and the Program/Project Manager shall be performed by the Contractor under this scope of work.
3. When local code authorities are required to witness tests, the Contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating the work with the Program/Project Manager.
4. The Contractor shall be responsible for obtaining all test documents with necessary approval stamps and signatures of the code authorities. The Contractor shall submit one copy of each of these documents to the Program/Project Manager.
5. Pre-acceptance Testing: Upon completion of each installation phase, perform and document on an approved format, system tests as described herein. Tests shall be performed in the presence of the Owner or designed representative:
 - a. Hydrostatic tests;
 - b. Test of sprinkler supervisory system;
 - c. Full trip test
6. Contractor shall provide at least five (5) working days' notice for all tests.
7. Final Approval: Final approval and acceptance of the work will be given by the Program/Project Manager when:
 - a. The completed sprinkler systems have been inspected, tested and approved by the Program/Project Manager and the Phoenix Fire and Development Services Departments.



- b. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools and training have been provided to, reviewed, and accepted by the Program/Project Manager.
 - c. Written certification is submitted that states all equipment is installed in accordance with the manufacturer's recommendations and UL or FM approvals. Additional Tests: Any additional tests, required by the referenced codes, standards, or criteria, or by the Program/Project Manager, shall be performed.
 - d. Additional Tests: Any additional tests, required by the referenced codes, standards, or criteria, or by the Program/Project Manager, shall be performed. This documentation shall include.
 - e. The date and time of each test.
 - f. A reference set of Contractor record drawings, numerically identifying the individual components.
 - g. A description of each test performed.
 - h. A completed NFPA 13 Test Document.
 - i. A checklist of each device tested, indicating the results of each test.
8. The final acceptance test shall Tests shall be performed in the presence of the Owner or designed representative, Phoenix Fire Department and Building Department:
- a. Hydrostatic tests;
 - b. Test of sprinkler supervisory system;
 - c. Full trip test

B. Training:

- 1. The Contractor shall conduct two (2) training sessions of four (4) hours each to familiarize the building personnel with the features, operation and maintenance of the sprinkler system. Training sessions shall be scheduled by the Program/Project Manager at a time mutually agreeable to the Contractor.
- 2. Final Agenda: The Contractor shall submit the final approved training agenda 14 days prior to the first training session.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 13968

CLEAN AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. New clean agent fire-extinguishing system (the system) for the MDF Room located in the GMP 3 Stage 1a Terminal 3.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Door sweeps and related devices and room features used to make the protected space air tight.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 02510 - Water Distribution.
 - 6. Section 07850 - Through Penetration Firestopping Systems.
 - 7. Section 09912 – Painting.
 - 8. Section 09960 - High-Performance Coatings.
 - 9. Section 13851 - Fire Alarm.
 - 10. Section 15995 - Commissioning of Mechanical Systems.
 - 11. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. FACU – Fire Alarm Control Unit.
 - 2. GMP: Guaranteed Maximum Price.
 - 3. MSDS: Material Safety Data Sheet(s).
 - 4. NICET - National Institute for Certification in Engineering Technology.
 - 5. NRTL: Nationally Recognized Testing Laboratory.
 - 6. UL – Underwriter’s Laboratory, Inc.
 - 7. UL FPED – Underwriter’s Laboratory, Inc. Fire Protection Equipment Directory.



B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
3. Clean Agent: Electrically nonconducting, volatile, or gaseous fire extinguishment that does not leave residue upon evaporation. The word agent as used in NFPA 2001 means clean agent unless otherwise indicated.
4. FM 200® Suppression System: A fire suppression system that employs gaseous FM-200®, chemically known as heptafluoropropane, to inhibit the chain reaction of fuel, heat, and oxygen.
 - a. FM-200® is a registered trademark of Great Lakes Chemical Corporation.
5. The System: New clean agent fire-extinguishing system that includes the necessary detection devices, releasing panel, and agent storage container.
6. Unifier: The web based management software/database system the Phoenix Sky Harbor International Airport (PSHIA) uses to manage all correspondence, requests for interpretation (RFI), submittals, and similar information related to construction activities for the PHX Sky Train Project.

C. Reference Standards:

1. City of Phoenix (COP):
 - a. International Building Code with City of Phoenix amendments 2006.
 - b. International Fire Code with City of Phoenix amendments 2006.
2. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
3. National Fire Protection Association (NFPA):
 - a. NFPA 13 - Standard for the Installation of Sprinkler Systems.
 - b. NFPA 70 - National Electrical Code® (NEC).
 - c. NFPA 72 – National Fire Alarm and Signaling Code.
 - d. NFPA 2001 – Clean Agent Fire Extinguishing Systems.
 - e. NFPA 14 – Installation of Standpipe and Hose Systems.
4. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:



- a. Fire Protection Engineering Technology Fire Alarm Systems Program Detail Manual.
5. Underwriters Laboratories, Inc. (UL):
 - a. UL 497B - Standard for Protectors for Data Communication and Fire Alarm Circuits.
 - b. UL 864 - Standard for Control Units and Accessories for Fire Alarm Systems.
 - c. UL 1971 - Standard for Signaling Devices for the Hearing Impaired.
 - d. UL 2127 – Standard for Inert Gas Clean Agent Extinguishing System Units.
 - e. UL Fire Protection Equipment Directory (FPED).
 - f. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.
6. United States Government:
 - a. Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities [Federal Register Volume 56 Number 144 (1991)].
 - b. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - c. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - d. Uniform Federal Accessibility Standards (UFAS), www.access-board.gov/ufas:
 - e. United States General Services Administration (GSA):
 - 1) Federal Standards:
 - a) FED-STD-795 - Uniform Federal Accessibility Standard.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Prior to commencement and after completion of the Work of this Section, provide written notification to the Program/Project Manager.
 2. Coordinate with the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 3. Coordinate the installation and testing of the system and the associated equipment and circuits with the appropriate Subcontractors, equipment



maintenance and testing representatives, the Sky Harbor International Airport Aviation Department, and the Authorities Having Jurisdiction.

- a. Coordinate the System Pre-Acceptance and the Final Acceptance Test of the system specified herein with the Program/Project Manager, the Sky Harbor International Airport Aviation Department, and other Authorities Having Jurisdiction (AHJ).
 - 1) At the time of notification, submit 1 copy of the approved Record Set of Drawings and the approved System Test Plan to the Program/Project Manager.
- b. Final Acceptance Test:
 - 1) In order to assure attendance at the Final Acceptance Test by the necessary representatives, provide reasonable notification of the test date to each representative scheduled to witness the test at least 48 hours prior to the test.
 - 2) Do not conduct this test until all parties agree on a test date.
4. Coordinate the networking of the system releasing panel to the new FACU.
5. Coordinate with the mechanical contractor for the installation of the fire smoke damper in the HVAC duct serving the room.
6. Coordinate with other trades on the installation of door sweeps, room seals, and penetration sealing.
7. Coordinate the dates and times of each required training session as specified herein through the Sky Harbor International Airport Aviation Department, not less than 2 weeks prior to the training session.
8. Conflicts Arising Due to Discrepancies between Documents:
 - a. Should conflicts arise due to discrepancies between documents referenced in this Section, the most stringent requirement applies; however, should a level of stringency be indeterminable, resolve the discrepancy as follows:
 - 1) The International Building Code (IBC), the International Fire Code (IFC), the National Fire Protection Association (NFPA) Standards, this Section shall take precedence over the Contract Drawings.
 - 2) The International Building Code (IBC) and the International Fire Code (IFC) take precedence over the National Fire Protection Association (NFPA) Standards, this Section, and the Contract Drawings.
 - 3) The National Fire Protection Association (NFPA) Standards shall take precedence over, this Section, and the Contract Drawings.
 - 4) This Section takes precedence over the Contract Drawings.

B. Sequencing:



1. Complete all component installation, and coordination of wiring, circuit testing in time so the fire alarm equipment Supplier can make the final connections and conduct tests of the fire alarm system as specified other sections without delaying the Work.

C. Scheduling:

1. Prior to beginning the Work of this Section, submit a schedule indicating the system installation sequence and time frame to the Program/Project Manager for approval.
 - a. Include specific time lines indicating the start and completion of major portions of the system installation.
 - b. Indicate the delivery dates of the equipment to be supplied.
 - c. Indicate the dates for the system Pre-Acceptance and the Final Acceptance Test specified herein.
2. Provide weekly schedule updates to the Program/Project Manager for approval.
3. Advise the Program/Project Manager of all anticipated projects the Contractor and the equipment Supplier may have with the same approximate completion date as this Contract, and what impact those projects may have on the timely completion of this Contract.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. The system shall provide a design concentration of 7% by volume for Class A hazards and a minimum of 5.85% by volume for Class B hazards in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. System design shall not exceed 10% for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation before agent release.

1.05 SUBMITTALS

A. Informational Submittals:

- a. Prior to performing any work, submit the following Contractor documentation in addition to those documents required elsewhere in this specification.
- b. Written confirmation of how the manufacturer/supplier plans to comply with the performance operational design of the system and all pertinent information regarding the reliability and operation of the equipment to be supplied.



B. Maintenance Material Submittals:

- 1) Provide per unit costs for additional devices and appliances to the Program/Project Manager with firm prices maintained for one year beyond the duration of the manufacturer's warranty period as specified herein.

C. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Original manufacturer's specification sheets.
 - b. Shop Drawings:
 - 1) Shop Drawings of the system.
 - 2) Working Drawings for installation of the system.
 - 3) Hydraulic/Phase Calculations.
 - c. Certificates:
 - 1) Project supervisor NICET certificate.
 - 2) Shop drawing technician NICET certificate.
 - d. Delegated Design Submittals:
 - 1) Preliminary Equipment List.
 - 2) Sequence of operation.
 - 3) Schedule indicating the installation sequence and time frame, and weekly schedule updates.
 - e. Special Procedure Submittals:
 - 1) System Test Plan.
 - f. Qualification Statements:
 - 1) System installer's qualifications.

D. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Firm fixed price for a year maintenance contract.
 - b. Operation and Maintenance Data:
 - 1) Suggested spare parts list of replacement system parts.
 - c. Warranty Documentation:
 - 1) System Materials Warranty.
 - 2) System Workmanship Warranty.
 - d. Record Documentation:
 - 1) Record Set of Drawings for the system.



E. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish one (1) ionization and one (1) photoelectric smoke detector.
 - 2) Furnish one "FM-200" strobe notification appliance.

1.06 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Authorities Having Jurisdiction:
 - a. To obtain approval of the system by the Program/Project Manager and the Authorities Having Jurisdiction, documents including Shop Drawings and material specifications prepared according to the requirements specified in NFPA 2001 are required.
 - b. Shop drawings shall be submitted to the Annual Facilities Permit program to the attention of Mary Schilling for review and approval.

B. Qualifications:

1. System Installer's Qualifications:
 - a. Employ a firm that is licensed in the State of Arizona, and that has a minimum of 5 years of documented experience installing fire sprinkler and standpipe systems similar in type to those required for this Contract.
 - b. Employ a firm that has installed clean agent systems for projects similar in scope to this Contract, and that has obtained design and inspection approvals for similar projects from the Authorities Having Jurisdiction.
 - c. Submit the qualifications of the proposed system installer and the resume of the proposed system installer's foreman and Project Manager-assigned to this Contract to the Program/Project Manager for approval.
 - 1) Include the number of years the proposed system installer has been in business, and their service policies, warranty definitions, and prior experience with installations that include the type of equipment that is to be supplied under this Contract.
 - a) Furnish a list of at least 3 installations similar in scope to this Contract, including the addresses of the properties, contact names, telephone numbers, and the types of system equipment installed.
 - 2) Include proposed system installer's personnel and company contact information.



- d. Nonconformance of the proposed system installer's qualifications with the qualifications specified in this Section are cause for immediate elimination of the proposed system installer without further comment.
 - e. Do not replace an approved system installer or the approved system installer's foreman without the written approval of the Program/Project Manager.
 - 1) No requested change in Subcontractor will be accepted unless justification is made in writing to the Program/Project Manager and approved.
 - a) Upon written request, the Program/Project Manager may authorize changes, but the decision to do so is at the sole choice and discretion of the Program/Project Manager.
2. System Technical Representative's Qualifications:
- a. To supervise the field installation of the system provided under this Contract, employ a trained and qualified technical representative who, at a minimum, holds a current NICET Level II Fire Protection Engineering Technology Special Hazard Fire Suppression Certification.
 - b. Submit the name and qualifications of the proposed system technical representative who will be in responsible charge of the installation of the system under this Contract to the Program/Project Manager for approval.
 - c. Do not replace an approved system technical representative without the written approval of the Program/Project Manager.
 - d. The specified system Shop Drawings and calculations must be prepared by a certified technician holding at a minimum NICET Level III Fire Protection Engineering Technology Special Hazard Fire Suppression Certification.
 - 1) Sufficient information to describe their qualifications, the work efforts to be performed, and the materials to be provided, including the names and qualifications of the Contractor's and the equipment Supplier's Project Manager who shall be in responsible charge during the entire project installation.

C. Certifications:

- 1. Listing and Labeling of Components, Devices, and Accessories:
 - a. Provide products listed in the UL Fire Protection Equipment Directory (UL FPED) and that are labeled with their intended use or classification.
 - 1) For major sections of the system, partial listings or multiple listings are unacceptable.



- 2) If a UL listing for a specific device is unavailable, products approved by FM Approvals LLC (FM) or another nationally recognized testing laboratory (NRTL) acceptable to the Sky Harbor International Airport Aviation Department will be acceptable.
- 3) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 1. Store and handle all equipment, devices, appliances, and other equipment and materials in accordance with the manufacturer's requirements.
 2. At the very least materials shall be stored in a neat and clean location that is protected from the elements and damage.
- B. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.08 WARRANTY

- A. Manufacturer Warranty:
 1. Have the manufacturer or the manufacturer's authorized representative warrant the new FM200 system materials against defects in material within the 2-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. Submit a written FM200 Materials Warranty, without monetary limitation, in which the manufacturer agrees to replace components of the new combination wet-pipe fire suppression sprinkler system that fail in materials within the specified warranty period to the Program/Project Manager for approval.



B. Special Warranty:

1. Warrant the FM200 system installed under this Contract against defects in workmanship and inherent mechanical and electrical defects within the 1-year period after the date of Substantial Completion or acceptance by the Program/Project Manager.
 - a. After the installation of the FM200 system, submit a signed written statement, substantially in the format that follows, to the Program/Project Manager:
 - 1) "The undersigned, having been engaged as the Contractor for Contract 131403 of the Phoenix Sky Train Project located in Phoenix, Arizona, confirms that the combination wet pipe fire sprinkler standpipe system equipment provided under the Contract has been installed in accordance with the approved system Shop Drawings, the manufacturer's installation instructions and technical specifications; and the Contract Documents."
 - b. Submit a written FM200 System Workmanship Warranty, without monetary limitation, in which the Contractor agrees to repair or replace components of the new FM200 system installed under this Contract that fail in workmanship or exhibit inherent mechanical and/or electrical defects within the specified warranty period to the Program/Project Manager for approval.

- C. Indicate service work not included in the warranty, and furnish a price for providing a service contract to cover the work not covered by the warranty.

PART 2 PRODUCTS

2.01 CONTRACTOR-FURNISHED PRODUCTS

A. New Products:

1. The system shall be a FM 200 Fire Suppression System supplied by a licensed distributor.
2. The system shall be complete in all ways. It shall include a mechanical and electrical installation, all detection and control equipment, addressable fire alarm control unit releasing panel, agent storage containers, agent, discharge nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, advisory signs, functional checkout and testing, training and any other operations necessary for a functional UL listed Clean Agent suppression system.
3. The fire alarm control unit releasing panel shall be compatible with the Stage 1a GMP 3 Terminal 3 Fire Alarm Control Unit.



4. The Project/Program Manager shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10-minute "hold" period.
5. The system(s) shall be actuated by a combination of ionization and photoelectric detectors installed for maximum area coverage of 450 sq. ft. (23.2 m) per detector.
6. Detectors shall be Cross-Zoned detection requiring two separate detector types to be in alarm before release.
7. Automatic operation of the protected area shall be as follows:
 - a. Actuation of one (1) fire detector, within the protected area, shall:
 - 1) Illuminate the "ALARM" lamp on the releasing control panel face.
 - 2) Energize the "FM-200" notification appliance.
 - 3) Actuate a pulse-tone audible alarm from the "FM-200" notification appliance.
 - 4) Transfer auxiliary contacts, which can perform auxiliary system functions such as: Operate door holder/closures on access doors; Transmit a signal to a fire alarm system; Shutdown HVAC equipment, and damper closure.
 - b. Actuation of a 2nd, cross-zoned fire detector or manual pull release station, within the protected area, shall:
 - 1) Illuminate the "PRE-DISCHARGE" lamp on the releasing control panel face.
 - 2) Actuate a steady-tone audible alarm from the "FM-200" notification appliance.
 - 3) Shut down the HVAC system.
 - 4) Start time-delay sequence (not to exceed 30 seconds).
 - 5) System abort sequence is enabled at this time.
 - c. After completion of the time-delay sequence, the Clean Agent system shall discharge and the following shall occur.
 - 1) Illuminate a "SYSTEM FIRED" lamp on the control panel face.
 - 2) Energize a visual indicator(s) outside the hazard in which the discharge occurred.
 - 3) Energize a "System Fired" horn/strobe.
 - d. The system shall be capable of being actuated by manual discharge devices located at the protected space exit. Operation of a manual device shall duplicate the sequence description above except that the time delay and abort functions shall be bypassed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

B. Manufacturers:

1. Manufacturer List:



a. General Requirements

- 1) The Clean Agent system materials and equipment shall be standard products of the supplier's latest design and suitable to perform all functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer.
- 2) The system design can be modular, central storage, or a combination of both design criteria.
- 3) Systems shall be designed in accordance with the manufacturer's guidelines.
- 4) Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.
- 5) The clean agent shall be stored in Clean Agent storage tanks. Tanks shall be super-pressurized with dry nitrogen to an operating pressure of 360 psi @ 70 °F (24.8 bar at 21 °C). Tanks shall be of high-strength low alloy steel construction and conforming to NFPA 2001.
- 6) Each tank shall have a pressure gauge and low pressure switch (optional) to provide visual and electrical supervision of the container pressure. The low-pressure switch shall be wired to the control panel to provide audible and visual "Trouble" alarms in the event the container pressure drops below 290 psi (20 bar). The pressure gauge shall be color coded to provide an easy, visual indication of container pressure.
- 7) Tanks shall have a pressure relief provision that automatically operates before the internal nominal pressure exceeds 730 psi (50 bar).
- 8) Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the clean agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution. Nozzles shall be available in 1/2 in. through 2 in. pipe sizes. Each size shall be available in 180° and 360° distribution patterns.
- 9) Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.

- b. The fire suppression agent shall be FM 200 Fire Protection Fluid.



- c. The detection control system and its components shall be UL listed and FM approved for use as a local releasing panel. The panel shall be compatible and able to be networked with the Stage 1a GMP 3 Terminal 3 FACU.
- d. The control system shall perform all functions necessary to operate the system detection, actuation, and auxiliary functions.
- e. The control system shall be microprocessor based, utilizing a distributed processing concept. A single microprocessor failure shall not impact operation of additional modules in the system.
- f. The control system shall be capable of supporting Cross Zoned Detection.
 - 1) The control system shall supply integrated 2.0 amp (minimum) power supply circuitry.
- g. Each control system shall contain release circuits for activation of a fire suppression system(s).
 - 1) Each circuit shall be capable of Class A operation.
 - 2) Each circuit shall be rated for a minimum of 1.5 amp @ 24 VDC.
- h. Each control system shall contain two (2) indicating appliance circuits for annunciation.
 - 1) Each circuit shall be capable of Class A operation.
 - 2) Each circuit shall be rated for a minimum of 1.5 amp @ 24 VDC.
- i. Each control system shall provide an auxiliary power supply rated for 2 amps @ 24 VDC.
- j. Each control system shall provide two (2) SPST relays: one for common alarm and one for common trouble. Four (4) additional programmable relays can be added to each control system by adding a relay module.
- k. The detectors shall be spaced and installed in accordance with the manufacturer's specifications and the guidelines of NFPA 72.
- l. The electric manual release shall be a dual action device which provides a means of manually discharging the suppression system when used in conjunction with the detection system.
- m. The manual release or manual pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.
- n. Manual actuation shall bypass the time delay and abort functions and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.
- o. Manual release shall be located at each exit from the protected hazard.
- p. The abort station shall be the "Dead Man" type and shall be located next to each manual release station.



- q. The abort station shall be supervised and shall indicate a trouble condition at the FM-200 control panel and the station FACU, if depressed, and no alarm condition exists.
 - 1) Locking or Keyed abort stations shall not be permitted.
- r. Alarm audible and visual signal devices shall operate from the control panel.
- s. The visual alarm unit shall be a strobe device.
- t. A strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign at each light location.
- u. Signs shall be provided to comply with NFPA 2001 and the recommendations of the FM 200 equipment provider.
- v. Entrance sign: (1) required at each entrance to a protected space.
- w. Manual discharge sign: (1) required at each manual release station
Flashing light sign: (1) required at each flashing light over each exit from a protected space.
- 2. System and Control Wiring
 - a. All system wiring shall be furnished and installed by the contractor.
 - b. All wiring shall be installed in electrical metallic tubing (EMT), or conduit, and must be installed and kept separate from all other building wiring.
 - c. All system components shall be securely supported independent of the wiring. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, and installed parallel and perpendicular to walls and partitions.
 - d. The sizes of the conductors shall be those specified by the manufacturer. Color-coded wire shall be used. All wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors. Final terminations between the control panel and the system field wiring shall be made under the direct supervision of a factory-trained representative.
 - e. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 725 and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72. Wiring installation shall meet all local, state, province, and/or country codes.
 - f. The complete system electrical installation and all auxiliary components shall be connected to earth ground in accordance with the National Electrical Code.
- 3. Substitution Limitations:



- a. No substitutions are permitted unless approved in writing by the Program/Project Manager.
- C. Finishes:
 - 1. Shop Finishing Methods:
 - a. The paint color and finish of all materials shall be approved in writing by the Project/Program Manager.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. It shall be the Contractor's responsibility to inspect the drawings and become familiar with the conditions under which the work will be performed.
 - 2. Cooperation with other trades: The clean agent Contractor shall coordinate with the work of the other trades towards the general purpose of having the construction progress as rapidly and as smoothly as possible with a minimum of interference between trades.
 - 3. Openings, cutting and patching: Before the start of Structural Work, the Contractor shall submit instructions for openings and penetrations required for his work to the Program/Project Manager. Instructions shall be subject to the Program/Project Manager's approval. The Contractor shall provide any subsequent additional penetrations or openings or relocation required, but not delineated in his instructions at no additional cost to the Program/Project Manager.
 - 4. Approval prior to installation: No work shall commence prior to approval of shop drawings by the Program/Project Manager. Any change in work which has been installed prior to approval of the shop drawings shall be made without additional compensation to the Contractor.
 - 5. All materials will be stored in a proper manner so they are not subject to damage, moisture, or other reasonable unforeseen circumstances.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Aesthetics shall be a primary consideration when installing the system piping. Any facet of the system installation that does not meet with the Program/Project Manager's approval shall be revised by the Contractor to the Program/Project Manager's satisfaction.



2. Holes: All holes made by the Contractor in any wall, ceiling, or floor shall be patched by the Contractor, restoring the wall, ceiling, floor or member to its original condition, fire resistance, and integrity.
3. General Locations: Location of all equipment, controls, piping, valves and drains shall be subject to Owner's approval.
4. Special Installation Instructions: All sprinklers and equipment shall be installed in accordance with manufacturer's instructions. All special tools recommended by the manufacturer shall be used.

B. Surface Preparation:

1. Remove all scale and foreign debris from the system piping. No damaged system components are permitted to be installed. No system components are permitted to be installed where there is evidence of manufacturer defect.

3.03 INSTALLATION

A. After the system installation has been completed, the entire system shall be checked out, inspected, and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards.

1. All containers and distribution piping shall be checked for proper mounting and installation.
2. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
3. The complete system shall be functionally tested in the presence of the Project/Program Manager or his or her representative and related authorities having jurisdiction. All functions, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.
4. Each detector shall be tested in accordance with the manufacturer's recommended procedures and test values recorded.
5. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, and local and remote alarms shall function as required and designed.
6. Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

B. Systems Integration:

1. Integrate FM-200 system with the Stage 1a GMP 3 Terminal 3 fire detection and alarm system. Alarm and Trouble signals from the FM-200 control unit shall be transmitted to the command center in Terminal 3.



3.04 SYSTEM STARTUP

- A. Upon completion of the installation of each system and a minimum of one (1) week prior to the Pre-Acceptance Test, the FM-200 Contractor shall deliver two (2) complete sets of the Test Plan to the Project/Program Manager, which shall describe how the system shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be employed. All tests shall be conducted in the presence of the Program/Project Manager and other parties identified and shall not be conducted until the "Test Plan" is approved.
- B. The Project/Program Manager shall provide three (3) complete indexed bound sets of the Operating and Maintenance (O&M) manual, as outlined in NFPA 2001, a minimum of two (2) week prior to the Pre-Acceptance Test of the system. These O&M manuals shall include the following:
 - a. The final Equipment List identifying the quantities and types of equipment listed by manufacturer's part number.
 - b. A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations.
 - c. An equipment datasheet (or specification sheet) on every piece of Clean Agent Suppression System equipment installed.
 - d. Operator instructions for basic system operations, including alarm acknowledgement, system reset, interpretation of system output, operation of manual evacuation signaling and ancillary function controls.
 - e. Standby power calculations and voltage drop calculations that accurately reflect with the equipment that has been installed in the building.
 - f. A point ID list referencing the signaling line circuit loops and the devices on those loops.
 - g. A sensitivity report for all smoke detectors at the time of acceptance.
 - h. The results of the testing of all wiring free from faults, as specified in this specification.
 - i. A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including testing and maintenance instructions for each type of device installed.
 - 1) This information shall include manuals that outline inspection, testing and cleaning procedures for all detectors and control equipment, as well as any other special maintenance procedures



- for any other pieces of Clean Agent Suppression System equipment installed in the building.
- 2) Detailed troubleshooting instructions for each trouble condition generated from the monitored field wiring, including opens, grounds, and loop failures.
 - 3) These instructions shall include a list of all trouble signals annunciated by the system, a description of the condition(s) that causes such trouble signals, and step-by-step instructions describing how to isolate such problems and correct them (or how to call for service, as appropriate).
- C. A service directory, including a list of names and telephone numbers of those who provide service for the system.

3.05 CLOSEOUT ACTIVITIES

- A. Pre-Acceptance Test:
1. Test Procedure:
 - a. The tests shall demonstrate that the entire control system functions as designed and intended. All circuits shall be tested: automatic actuation and manual actuation, HVAC and power shutdowns, audible and visual alarm devices, and manual override of abort functions. Supervision of all panel circuits, including AC power and battery power supplies, shall be tested and qualified.
 - 1) A room pressurization test shall be conducted in each protected space to determine the presence of openings, which would affect the agent concentration levels. The test(s) shall be conducted using the Retro- Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001.
 - 2) If room pressurization testing indicates that openings exist which would result in leaks and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the Project/Program Manager or his or her sub-contractor or agent. The Project/Program Manager shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing contractor shall coordinate an inspection all work to ascertain that the protected space(s) have been adequately and properly sealed. If the first room pressurization test is not successful, in accordance with these specifications, the installing Contractor shall deliver the test results to the Program/Project Manager and assist in determining the cause of the test failure.



The installing Contractor shall conduct additional room pressurization tests, at no additional cost to the Program/Project Manager, until a successful test is obtained. Copies of successful test results shall be submitted to the Program/Project Manager for his record. Upon acceptance by the Program/Project Manager, the completed system(s) shall be placed into service.

B. Final Acceptance Test

1. The final acceptance tests shall demonstrate that the entire control system functions as designed and intended. All circuits shall be tested: automatic actuation and manual actuation, HVAC and power shutdowns, audible and visual alarm devices, and manual override of abort functions. Supervision of all panel circuits, including AC power and battery power supplies, shall be tested and qualified.
 - a. A room pressurization test shall be conducted in each protected space to determine the presence of openings, which would affect the agent concentration levels. The test(s) shall be conducted using the Retro-Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001.
 - b. The test shall be conducted in the presence of the Program/Project Manager and Authorities Having Jurisdiction.
2. If room pressurization testing indicates that openings exist which would result in leaks and/or loss of the extinguishing agent, the installing Contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the Project/Program Manager or his or her Subcontractor or agent. The Project/Program Manager shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing Contractor shall coordinate an inspection of all work to ascertain that the protected space(s) have been adequately and properly sealed. If the first room pressurization test is not successful, in accordance with these specifications, the installing Contractor shall deliver the test results to the Program/Project Manager and assist in determining the cause of the test failure. The installing Contractor shall conduct additional room pressurization tests, at no additional cost to the Program/Project Manager, until a successful test is obtained. Copies of successful test results shall be submitted to the Program/Project Manager for his record. Upon acceptance by the Program/Project Manager, the completed system(s) shall be placed into service.

3.06 TRAINING:

- A. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the Owner's personnel. Each training session shall



include control panel operation, manual and (optional) abort functions, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 14215

MACHINE ROOM-LESS ELEVATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All Documents and related specification sections associated with these elevators included in Package B01

1.02 GENERAL DESCRIPTION:

- A. Duplex Passenger Elevators and Simplex Passenger Elevator with adjacent or remote controllers as shown on the contract documents.
- B. Provide all engineering, equipment, labor and permits required to satisfactorily complete design, fabrication, installation, testing and commissioning of five (5) elevator installations as required by contract documents for Machine Room-Less elevators at the 24th Street Station and Rental Car Center Station at Phoenix Sky Harbor International Airport. The components provided shall comply with heavy duty transit APTA guidelines as specified herein.
- C. The Installer is to ensure that all work is performed in accordance with the requirements of local codes and regulations, which govern the requirements of the work specified. All equipment, design, clearances, construction, operation and tests are required to be in accordance with these specifications and the ASME/ANSI A17.1 - Safety Code for Elevators and Elevators and all pertinent codes, regulations and rules being enforced by the City of Phoenix Planning and Developmental Services.
- D. The Installer is required to perform thorough field surveys in addition to providing all engineering, labor, materials, storage, tools, equipment, supervision and transportation in order to fulfill the requirements for design, engineering, fabrication, and installation of the elevator equipment in a complete first-class manner and in accordance with the requirements of the contract documents.
- E. Whenever a reference is made to a part of the equipment being provided in a singular number, it applies to as many such items that may be required to provide a complete installation.
- F. Any equipment not specifically identified within the contract documents but that is essential to the Code and contractual compliant installation and operation of the equipment specified herein is to be provided by the Contractor as if the same was identified in the specification.



- G. Specifications indicate the arrangement of the elevator work to be provided. The Installer is to carefully review these documents along with field conditions and the overall design of the project, as the Installer will be responsible for the proper fitting and installation of the equipment specified. Contractor is required to work closely with the Program/Project Manager.
- H. Provide all required staging, hoisting, hoist/safety beams, and equipment necessary for the movement of equipment.
- I. Transportation and Handling: Materials, products and equipment shall be properly packaged and protected from damage during transportation, storage and handling. Coordinate delivery and movement of large items in the Phoenix Sky Harbor International Airport facilities with City of Phoenix Aviation Department.
- J. Product Delivery, Storage and Handling:
 - 1. Deliver material in manufacturer's original, unopened protective packaging.
 - 2. Protect equipment and exposed finished from damage and stains during transportation, erection and construction.
 - 3. Available storage space at the site is limited. Any additional off-site space required, including cost, is responsibility of the Installer.
 - 4. Locate available site storage areas and coordinate use with City of Phoenix Aviation Department and the work of other contractors.
 - 5. Provide suitable temporary weather-tight storage facilities as may be required for materials that will be stored in the open.
- K. Installer is to provide any and all information as required for the appropriate coordination of work to be performed by other trades. Address any possible impacts on the installation schedule.
- L. Commissioning Requirements: Completion of the elevator work requires of the Installer to have the equipment completely inspected in accordance with the specifications in order to demonstrate that the equipment, as installed, conforms to the specifications and code requirements. All labor, tools and equipment necessary to conduct the onsite commissioning inspections and testing are the responsibility of the Installer. The commissioning inspections and tests will be performed by the Program/Project Manager prior to the inspection by the City of Phoenix Elevator Inspector.
- M. The Installer has no advertising privileges related to this project unless specific written permission is obtained from the owner. Installer is required to maintain the work area free from any and all posters, signs and decorations. Installer's name, trademarks, logos or other identifying symbols are not to appear on any surface on the equipment visible to the general public.



1.03 DEFINITIONS:

- A. Elevator, Passenger: An elevator used primarily to carry persons other than the operator and persons necessary for loading and unloading.
- B. Elevator, Gearless: A traction machine, without intermediate gearing, that has the traction sheave and the brake drum mounted directly on the motor shaft.
- C. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
- D. Dwell Time: The period of time the elevator is at a landing while the doors open, passengers transfer and doors close.
- E. Installer: The installer is the contractor, or subcontractor, responsible for furnishing and installing the elevators. For this project it will be the Vertical Transportation Equipment Supplier.
- F. Contractor: Any responsible party involved in the installation other than the installer of the elevators. For this project it will be considered the CM@Risk.
- G. Program/Project Manager: This is considered the Vertical Transportation Design Professional for the project. He will be responsible for design coordination, submittal review, construction support/inspection services, and commissioning on behalf of the Owner.
- H. APTA – American Public Transit Association

1.04 TEMPORARY AND PERMANENT ELECTRICAL POWER SERVICES TO BE PROVIDED BY OTHERS

- A. Temporary power for installation shall be made available to Installer at the time of the installation. Permanent power shall be made available for testing. All power shall be provided at no cost to Installer.
- B. For elevator drive systems: 480 volts, 3-phase, 3-wire, 60 Hertz terminating in a disconnect switch within sight of the controller.
- C. For lighting and GFCI receptacles: 120 volts, 1-phase, 3-wire, 60 Hertz terminating at the elevator controller location.
- D. Separate disconnect for cab lighting and wiring to cab: 120 volts, 1-phase, 3-wire, 60 Hertz terminating in a disconnect switch within sight of the controller.



1.05 APPLICABLE CODES, STANDARDS, AND PUBLICATIONS:

- A. Elevators designs and installations shall comply with the following.
1. ASME A17.1 - Safety Code for Elevators and Escalators; applicable edition
 2. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks; applicable edition
 3. ASME A17.5 – Elevator and Escalator Electrical Equipment, applicable edition.
 4. European Norm – EN 115
 5. Local Fire jurisdiction
 6. Life Safety Code, NFPA 101
 7. Uniform Federal Accessibility Standard (UFAS)
 8. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; applicable edition
 9. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; applicable edition
 10. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); applicable edition
 11. ASTM A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; applicable edition
 12. ASTM A 490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); applicable edition
 13. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; applicable edition
 14. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; applicable edition
 15. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar; applicable edition
 16. ASTM B 138/B 138M - Standard Specification for Manganese Bronze Rod, Bar, and Shapes; applicable edition
 17. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; applicable edition
 18. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); applicable edition
 19. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; applicable edition
 20. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); applicable edition
 21. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; applicable edition
 22. AWS D1.1 - Structural Welding Code - Steel; applicable edition
 23. NFPA 70 - National Electrical Code; applicable edition



24. UL (ECMD) - Electrical Construction Materials Directory; current edition
25. ANSI Y14.3 Multi and Sectional View Drawings
26. International Building Code, applicable edition
27. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
28. American Public Transit Association (APTA) Low and Mid-Rise Elevator Guidelines
29. AFBMA (Anti-Friction Bearing Manufacturers Association) – Std. 9 and 11

- B. Specifications and references contained within this section are not to be construed as supplanting any code requirements governing the design, fabrication, installation or operation of the equipment.
- C. The most stringent requirement shall take precedent in case of a conflict between codes, regulations or standards incorporated into this section.
- D. Any specific provision cited herein and/or shown on the contract documents shall govern for the specified application.
- E. The Installer shall be licensed and strictly governed by local and governmental authorities of this area in order to perform this work.

1.06 DESIGN CRITERIA:

- A. General
 1. Elevators shall be designed with provisions for thermal expansion and contraction of complete elevator systems. They shall be designed to meet the operating and performance requirements of these specifications, to fit within the spaces provided, and to comply with all Code requirements.
- B. Operational Requirements
 1. Hours of operation shall be considered as twenty-four (24) hours per day, seven (7) days per week.
 2. Elevator components shall be designed based on the following applied duty cycle during operation:
 - a. Two separate three (3) hour periods with 90% rated load (total 6 hours).
 - b. Eighteen (18) hours with 50% rated load.
 3. Maximum dwell time per landing in these calculations shall be no more than 10 seconds.
- C. Environmental Requirements
 1. General: Elevator shall be capable of operating with full-specified performance capability while exposed to the following climatic and environmental conditions.
 - a. Interior installations: Elevators shall be designed to operate in a temperature range of plus (+5) to plus one hundred and twenty



(+120) degrees Fahrenheit, dry bulb; and all conditions of relative humidity while exposed to airborne dust and debris.

- D. Seismic Zone Requirements: The elevator shall be designed to comply with seismic zone 2 requirements of ASME A17.1-2010 regardless of edition of ASME A17.1 approved for this project. The sole exception to this requirement is where the Owner has designed the structure for a more stringent seismic requirement.
- E. Fasteners:
 - 1. Fasteners shall be compatible with materials being fastened
 - 2. Fasteners shall be furnished with self-locking nuts or retaining rings (spring washers, toothed disks).
 - 3. Fasteners shall be equal to or of greater corrosion resistance than the most corrosion resistant metals being fastened.
- F. Bearings
 - 1. Bearings shall be rated for an AFBMA L10 life as specified, under a fluctuating bearing load. All bearings shall have dynamic load ratings.

1.07 SUBMITTALS

- A. General: Submittal shall contain sufficient detail to show full compliance with Contract Documents.
- B. Product Data:
 - 1. Submit expected heat dissipation of elevator equipment in controller room and overhead machine space (i.e. BTUs/hr).
 - 2. Submit manufacturer's product data for each product and material
 - 3. Indicate manufacturer, trade names, and model numbers, components, arrangement, optional and accessories being provided.
 - 4. Include applicable literature, catalog material or technical brochures.
 - 5. Include material and equipment specifications, sizes, types, dimensions, weights, rated capacities, and performance curves.
 - 6. Include utility requirements for wiring, piping, and service connection data, motor sizes complete with electrical characteristics.
- C. Shop Drawings: Information to be provided to Program/Project Manager will include but not be limited to the following:
 - 1. Six (6) copies of the layout and shop drawings shall be provided by the Contractor for review within three weeks of notice to proceed.
 - 2. All drawings, views and details shall be developed and presented in accordance with ANSI Y14.3 Multi and Sectional View Drawings.
 - 3. Drawings shall clearly reflect dimensional data for elevator hoistways including cross references to building column lines and finish elevations depicted in the Contract Documents.



4. Elevator layout shall be shown in three orthogonal views and shall include key dimensions, support details, power connection locations and power connection terminal points.
5. Shop drawings: Six (6) copies of the shop drawings shall be provided by the Installer. Submit approval layout drawings to scale. Drawings shall include, but not be limited to the following:
 - a. Car, counterweight, guide rails, buffers, machine, governor and other components in hoistway
 - b. Maximum rail bracket spacing.
 - c. Maximum loads imposed on guide rails requiring load transfer to the building structure
 - d. Loads on hoisting beams.
 - e. Clearances and travel of car and counterweight run-by.
 - f. Clear inside hoistway and pit dimensions.
 - g. Location and sizes of access doors, hoistway entrances and frames.
 - h. Car & Hall signal and operating fixtures.
 - i. Remote wiring layouts for each elevator.
 - j. Refuge space on top of car and pit.
 - k. Control room, machine area, pit and hoistway layout.
 - l. Cab design, dimensions and layout.
 - m. Hoistway-door and frame details
6. Complete assembly detail of machine, machine mounting, machine beam assembly, dead end hitch and beam assemblies, governors, safeties, counterweights, with all load calculations.
7. Shop drawings shall include complete schematic and connection diagrams for the controller and all electrical devices including a legend for components.
8. Controller information shall include complete I/O list.
9. An I/O list of items to be monitored by the remote monitoring system (Lift Net) shall be provided for review and approval.
10. All drawings shall reflect existing field measured as-built conditions.

D. Samples:

1. Submit [6] samples minimum 6"x 6" in size of all finish materials including but not limited to the following:
 - a. Cab Flooring
 - b. Ceiling, including surface material, supporting frame and light fixture
 - c. Cab Interior including car door, front return, wall finish etc.
 - d. Fixture faceplate with Engraving
2. Samples shall be clearly labeled to reflect:
 - a. Project Name
 - b. Contract Number
 - c. Description of Sample



- E. Maintenance programs: within sixty (60) days after notice to proceed, and prior to installation, Installer shall submit detailed Maintenance Control Plan as required by Code specific to the elevator equipment being installed.
- F. Operating and Maintenance manuals: Prior to installation, Installer shall submit six (6) complete sets of Operation and Maintenance manuals for approval: After Owner approval and prior to the beginning of acceptance testing, six (6) sets of the approved manuals shall be provided by the Installer. The manuals shall include the following:
 - 1. Complete table of contents.
 - 2. Complete instructions regarding operation and maintenance of equipment, including complete illustrated, exploded views of all assemblies, and a complete, illustrated, exploded view for identifying all system parts.
 - 3. Complete nomenclature of replaceable parts, part numbers, current cost, and warehouse location. If product source is another vendor, Installer shall include name and address of other vendor.
 - 4. Sample copies of a preventive maintenance chart.
 - 5. Descriptions of safety devices.
 - 6. Safety rules, tests, and procedures, including testing of all systems and subsystems.
 - 7. Procedures for adjusting all elevator equipment, including pictorials.
 - 8. Troubleshooting techniques.
 - 9. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.
 - 10. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each elevator or group of elevators.
 - 11. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in machinery/control room spaces and pits.
 - 12. Complete detailed drawings and wiring diagram of elevator system.
 - 13. Electronic and hard copies of ladder diagrams, logic and controller program.
 - 14. Controller information shall include complete I/O list.
 - 15. Provide one (1) laminated set of wiring diagrams mounted in the controller room.
 - 16. As-built drawings for final elevator installation, controller and hoistway wiring. Also provide As-built drawings in electronic format approved by the Owner.
 - 17. At substantial completion, an elevator adjuster level laptop used by the elevator adjuster for this project shall be provided to the Owner.
- G. Certification:
 - 1. The elevator manufacturer shall provide to the operating authority, with copies of all documents related to maintenance, safety, operations, design



- changes, modifications, and retrofits which relate to any part, component, equipment, system, subsystem, or material and services applicable to the elevators provided.
2. All of the above-referenced shall be provided as it pertains to the original installation and for a period of ten (10) years after final acceptance of the last elevators provided under any contract.
 3. The referenced material shall be provided within thirty (30) days of publication or internal distribution by the elevator manufacturer. The material, even if labeled PROPRIETARY, shall be delivered to the Owner without prejudice or delay and at no additional cost.
 4. Provide all material on CD-ROM in a format approved by the Owner.
- H. MSDS and product data sheets: Shall be submitted with an index listing each product, along with the application method of the product, approximate quantity of product per elevator and the component the product is applied to or associated with. The Installer shall allow 6 (six) weeks for review of MSDS.
- I. Installer shall provide copies of welder's certification in accordance with Part 1.08B.

1.08 QUALITY ASSURANCE:

- A. Regulatory agencies: elevator design, materials, construction clearances, workmanship, and tests shall conform to the requirements of the codes and regulations listed in Part 1.05.
- B. Welding: Welding shall be performed in accordance with the requirements of AWS or CWB. Welders shall produce evidence of current certification by AWS or CWB.
- C. Requirements of Regulatory Agencies
1. Installer shall obtain and pay for all necessary permits and perform such tests as may be required for acceptance and approval of elevators by jurisdictional agencies.
 2. Installer shall notify the proper inspectors to witness required testing.
- D. Factory Visit
1. The Installer shall provide for the costs of up to three of the operating authorities representatives including the Program/Project Manager to visit the factory where the elevators are being manufactured, per contract, per unit type.
 2. Installer shall not ship the elevator without the approval of the Program/Project Manager after the conclusion of the factory visit.
- E. Labeling
1. Elevator controller shall be clearly marked permanently on the controller cabinet door with rated load and speed, manufacturer serial number, and



designated City of Phoenix and Phoenix Sky Harbor Airport identification numbers.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping Packing, Shipping, Handling, and Unloading:
 - 1. Accept equipment, materials, and other Products on site in factory containers, bundles, and shipping skids.
- B. Delivery and Acceptance at Site:
 - 1. Deliver material in original packages, containers, skid loads, or bundles bearing brand names and identification of source of manufacture or supply.
 - 2. Inspect deliveries for damage.
- C. Storage and Protection:
 - 1. Store materials inside under cover and in a dry location.
 - 2. Protect from weather, direct sunlight, surface damage, corrosion, and construction traffic and activity.
 - 3. Installer shall make necessary provisions to protect systems from damage, deterioration, and environmental conditions during installations and until elevator systems are fully operative.
- D. Handling:
 - 1. Handle material to prevent damage to edges, ends, surfaces, and finishes.

1.10 PROJECT/SITE CONDITIONS

- A. Project Conditions:
 - 1. Coordinate the elevator installation with required utility services and the work of other trades involved on the project.
 - 2. Sequence installation to insure utility connections are made in an orderly and timely manner.
 - 3. Installer shall coordinate lock and key requirements with the Owner.
- B. Site Conditions:
 - 1. Installer shall design and fabricate elevator components to fit within the space allocated by the Design Team. Structures will not be modified to meet the requirements of the Installer's equipment. If Installer requires modification to existing structures, they will be responsible for the timely submission of shop drawings and documentation to the Program/Project Manager so that the Program/Project Manager can convey this information to the Design Team in order for the modifications to be made to the current design.
 - 2. Installer shall review site conditions and measure as-built dimensions for hoistway and pit prior to delivery of equipment to the site.



3. Installer shall coordinate with the Owner in relation to connections between elevator equipment and CCTV, remote monitoring system, communications, fire alarm initiating devices and system, shunt trip breakers, power and cab lighting.
4. Installer shall coordinate with the contractor all requirements in relation to mounting of elevator equipment and guide rails in the hoistways.

1.11 ACCEPTANCE AND WARRANTY

- A. The Installer shall warrant in writing that all equipment manufactured and installed under this specification, for a period of twelve (12) months from the date of Final Acceptance by the Owner, be free of defects in design, materials, and workmanship, under normal use and service. Defective work shall be repaired or replaced at no additional cost to the Owner.
- B. The warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to, noisy, rough, or substandard operation; loose, damaged, and missing parts; and fluid leaks.
- D. Warranty Maintenance Requirements: NONE – maintenance services will be provided by the incumbent service provider at the completion of construction.

1.12 GUARANTEES

- A. Notwithstanding the Specifications forming a part of this Contract, any inspection or approval of the Work by the Owner, or the existence of any patent or trade name, the Installer nevertheless unconditionally guarantees that the equipment furnished and installed hereunder shall be of the best quality and shall be fully fit for the purpose for which it is intended.

1.13 OWNER INSTRUCTION / DEMONSTRATION AND COORDINATION

- A. The Installer shall provide eight (8) hours of onsite demonstration and instructions to the Owner and existing service personnel upon completion of the elevator installation. Instructions are to include safety procedures, proper operation of all equipment, including remote monitoring system, and routine maintenance procedures. All instructions and demonstrations are to be video recorded and remain the property of the Owner.
- B. Check operation of the elevators with Owner's personnel or designated representative present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.



PART 2 PRODUCTS

2.01 GENERAL

- A. Installer shall furnish and install elevators that shall comply with the following requirements:
 - 1. All elevators supplied under this contract shall be the product of a single manufacturer.
- B. Acceptable Machine Manufacturers:
 - 1. KONE Elevator Company
 - 2. Otis Elevator Company
 - 3. Schindler Elevator Company
 - 4. ThyssenKrupp Elevator Company
- C. Acceptable Controller Manufacturers:
 - 1. KONE Elevator Company
 - 2. Otis Elevator Company
 - 3. Schindler Elevator Company
 - 4. ThyssenKrupp Elevator Company
 - 5. G.A.L. Manufacturing
 - 6. Motion Control Engineering
 - 7. SmartRise
 - 8. Virginia Controls
- D. Acceptable Drive Manufacturers:
 - 1. KONE Elevator Company
 - 2. Otis Elevator Company
 - 3. Schindler Elevator Company
 - 4. ThyssenKrupp Elevator Company
 - 5. KEB
 - 6. Magnetek
- E. Subject to compliance with the requirements of the Section, Elevator Cab design shall be coordinated with the Architect and Program/Project Manager. Installer is to include an Allowance of \$25,000 per elevator cab interior (which only includes walls, ceilings, returns and transom) in their bid.

2.02 MATERIALS:

- A. Except where product conformance to specific standards is indicated on the Contract Documents and in ASME/ANSI A17.1, OEM's standard materials and equipment may be used in elevator construction, subject to approval. Materials cited below are intended to establish the standard of quality for comparable materials used by the manufacturer.
- B. Structural Shapes, Plates, Sheets, and Tubing: ASTM A36 Steel.



- C. Sheet Steel: ASNI/ASTM A446, Grade B.
- D. (ALL) Stainless Steel: ASTM A167, Type 304
 - 1. Finishes to be coordinated with Architect and Program/Project Manager.
- E. Aluminum: ASTM B211 or ASTM B221, Alloy 6061, T6.
- F. Flooring: Design of elevators should account for 3/8" thick epoxy matrix thin-set terrazzo on a flexible epoxy crack suppression membrane. Subfloor provided by installer shall be stainless steel plate construction. Color to be selected by the Architect and flooring to be installed by others.

2.03 SPECIAL FEATURES

- A. General:
 - 1. Elevator shall be of size, arrangement, capacity and shall comply with design criteria specified in this Section and as shown on the Contract Documents, and in accordance with the requirements of the ANSI/ASME A17.1-Safety Code for Elevators and Escalators, hereinafter in this Section the "Code".
 - 2. Provide all material and equipment necessary for the complete execution of all elevator work as specified in this Section and as shown on the Contract Documents.
 - 3. Provide hoistway guards for protecting hoistway during construction. Hoistway protection shall include high solid panels surrounding each hoistway opening at each floor.
 - 4. All electric equipment, conduit, fittings and wiring shall conform to the requirements of ANSI/NFPA No. 70 National Electric Code.
 - 5. Provide concrete inserts and other similar anchoring devices for the installation of guide rails, machinery and other elevator components. Epoxy ceiling anchors or epoxy side wall anchors shall not be permitted.
 - 6. Clearance around equipment located in each elevator control room and machine area shall comply with the applicable provisions of ANSI/NFPA No. 70 National Electrical Code.
 - 7. All elevators will be on Emergency Power and all signal communication requirements are to be coordinated with the contractor by the installer for proper testing and function.
 - 8. All elevators will be tied to a new Remote Monitoring System as manufactured by Lift Net that shall be provided by the installer as part of this contract. Communication protocol as well as elevator items to be monitored to be coordinated with the contractor, Owner and Program/Project Manager.

2.04 SUMMARY OF FEATURES:

- A. Machine Room-Less Elevators



1. Elevator Use: Passenger
2. Contract Load, in pounds: As per Contract Documents
3. Contract Speed, in FPM: As per Contract Documents
4. Travel Distance: As per Contract Documents
5. Platform Size: As per Contract Documents
6. Number of Stops: As per Contract Documents
7. Number of Openings: As per Contract Documents
8. Operation: Selective/Collective
9. Machine Location: Overhead within Hoistway
10. Controller Location: As per Contract Documents
11. Machine Type: AC gearless machine room-less
12. Motor Horse Power: As required for specified duty
13. Power Supply: As per Contract Documents
14. Lighting/ Signal Power Supply: As per Contract Documents
15. Ancillary/Auxiliary Power Supply: As per Contract Documents
16. Car/Hoistway Door Size: As per Contract Documents
17. Car/Hoistway Door Type: Single Speed Center Opening
18. Car/Hoistway Door Operation: Linear Type Power High-speed, heavy duty (Minimum opening speed 3.0 FPS, Minimum closing speed 5.0 FPS)
19. Hoistway Entrance: As per Contract Documents
20. Cab Enclosure: As per Contract Documents
21. Cab Flooring: As per Contract Documents
22. Door-Reversal Device: Infrared, Full Screen 3D Device, with Differential Timing, Nudging and Interrupted Beam Time – Janus Panachrome 3D or approved equal. (3D shall be turned off at turnover.)
23. Car Operating Panel: As per Aviation Department Standard manufactured by Innovation Industries.
24. Car Position Indicator: As per Contract Documents As per Aviation Department Standard manufactured by Innovation Industries.
25. Car Direction Indicator: As per Contract Documents As per Aviation Department Standard manufactured by Innovation Industries.
26. Hall Call Stations: As per Contract Documents As per Aviation Department Standard manufactured by Innovation Industries.
27. Communication System: Coordinate with Project/Program Manager per Aviation Department Standard
28. Security Features: Coordinate with Project/Program Manager per Aviation Department Standard
29. Guide Rails: As per Contract Documents
30. Buffer Type: As per Contract Documents
31. Additional Features:
 - a. ADA and Emergency Medical Services Access and Signage
 - b. Hoistway Access Switches at Top and Bottom Floors
 - c. Independent Service Feature
 - d. Combination Vertical and Horizontal Sensor Type Seismic Switch



- e. Counterweight Derailment Device
- f. Whisper Flex Type Compensation, if compensation means is required by the manufacturer
- g. Firefighter's Control Panel and Remote Wiring, if applicable
- h. Tamper Resistant Fasteners for Signal Fixture Faceplates
- i. Firefighter's Telephone Jack, if applicable.
- j. Two-Way Communication System between Machine Room and Elevator Cab where required by code
- k. Emergency Paging Speaker Installation
- l. Card Reader Provisions
- m. CCTV Provisions
- n. Remote Monitoring- Lift Net provided by Installer
- o. Battery Pack Emergency Car Lighting. Provide Separate Constant Pressure Test Button in Car Service Compartment to Illuminate Portion of Normal Car Lighting
- p. Signage Engraving filled with Colored Paint per Aviation Standard
- q. No Visible Company Name or Logo
- r. System Diagnostic Means and Instructions
- s. No Special Tools shall be required to troubleshoot and maintain elevator system
- t. Roller type Car and Counterweight Guides
- u. Load Weighing Device
- v. LED Car Lighting as manufactured by Man-D-Tec or approved equal.
- w. All hoistway and car door rollers shall utilize polypropylene material for the wearing surface of the rollers.

2.05 CAR PERFORMANCE

- A. Car Speed: + or – 3% of contract speed under any loading condition.
- B. Car Capacity: Safely lower, stop and hold 125% of rated load.
- C. Car Stopping Zone: + or – ¼" under any loading condition.
- D. Door Opening Time: Seconds from start of opening to fully open;
 - 1. In accordance with NEII Standards
- E. Door Closing Time: Seconds from start of closing to fully closed;
 - 1. In accordance with NEII Standards
- F. Car Floor-to-Floor Performance Time: Seconds from start of doors closing until doors are ½ open and car level and stopped at next successive floor under any loading condition or travel direction
 - 1. Based on capacity, speed, door size, and travel distance per Contract Documents.



G. Car Ride Quality

1. All elevators shall have a minimum decibel reading of 60 Dba with the doors closed during a run in the up direction, measured 5 feet above the floor in the center of the cab.
2. All elevators shall have a maximum vibration of 30 milli-g's in the X, Y and Z axis measured with an A95 filter.
3. Acceleration and Deceleration: Smooth constant and not more than 3 feet/second² with initial ramp between 0.5 and 0.75 second.
4. Sustained Jerk: Not more than 8 feet/second³
5. Ride quality shall be verified in the field with an EVA-625 (as manufactured by PMT, Inc. or approved equal) placed in the center of the cab floor.

2.06 DOOR OPERATOR EQUIPMENT:

- A. Provide Linear Type door operator with encoder-less VVVF drive or approved equal. Closed loop door operator designed to operate car and hoistway doors simultaneously at the speed specified. Door shall open automatically when car stops at landing to discharge passengers or to answer valid calls and close automatically after predetermined time interval has elapsed. The doors shall be capable of smooth and quiet operation without slam or shock. Door operator to have the following features.

1. ½ hp motor and heavy-duty sprocket, chain, belt, and sheaves
2. Closed loop regulated speed performance
3. Hand-held keypad or built-in programming
4. Adjustments can be stored in the keypad and downloaded to another operator
5. Adjustable door obstruction reversal unit
6. Optical cams with LED indicators
7. Test switches for open, close, nudging and speed zone set up
8. Universal inputs for open, close, and nudging
9. Reversing switch to back up the door reversal device.

- B. Cab Door Interlock. The doors on cab doors shall be equipped with approved cab door interlocks of the cab unit system type tested as required by the Code.

1. Interlock shall prevent operation of the car away from a landing until doors are locked in the closed position. Interlock shall prevent doors from opening at any position within the hoistway and or landing from the cab side unless car is at rest at that landing, or is in the leveling zone and stopping at that landing.
2. Cab door unlocking devices shall conform to the requirements of the Code and shall be provided to permit authorized persons to gain access to hoistway when car is away from landing
3. Provide an electric contact mounted on the car that will prevent the car from moving away from landing unless car doors are closed.



C. Door Control Device:

1. Door Protection: Electronic Entrance Detector Screen: Provide an electronic door detector device and or approved equal, which projects an infrared curtain of light guarding the door opening. Arrange to reopen doors if one beam of the curtain is penetrated. Unit shall have transmitters and receivers spaced at a minimum distance to provide the maximum amount of protection within the height of the doorway. Systems, which have the ability to turn Off or On individual zones within the curtain, will not be allowed. Unit must provide a visual cue when doors are open and when doors start to close as per Janus Panachrome 3D or approved equal. The 3D operation should be capable of being changed to 2D by the City of Phoenix Aviation Department if desired.
2. Nudging Operation: After beams of door control device are obstructed for a predetermined time interval (minimum 20.0-25.0 seconds), a warning signal shall sound and doors shall attempt to close with a minimum of 2.5-foot pounds kinetic energy. Activation of the door open button shall override nudging operation and reopen doors.
3. Interrupted Beam Time: When beams are interrupted during initial door opening, hold door open a minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold time, reduce time doors remain open to an adjustable time of approximately 1.0-1.5 seconds after beams are reestablished.
4. Differential Door Time: Provide separately adjustable timers to vary time that doors remain open after stopping in response to calls.
 - a. Car Call: Hold open time adjustable between 3.0 and 5.0 seconds.
 - b. Hall Call: Hold open time adjustable between 5.0 and 8.0 seconds.

2.07 HOISTWAY EQUIPMENT:

A. Guide Rails:

1. Guides shall be steel T-section rails. Rail surfaces shall be machined smooth to insure proper operation of guides. Rail ends shall be accurately machined with tongue and matching groove centrally located on web. Non-wearing rail surfaces are to be painted at the completion of the elevator in color selected by the Architect.
2. Guides shall be joined and installed in accordance with Section 2.23 of the Code.

B. Car and Counterweight Buffers: Provide spring type with blocking and support.

C. Guide Assemblies: New roller guide assemblies of the size and type required for the applicable application shall be mounted on top and bottom of the car and counterweight frames to engage the guide rails. Each guide shall consist of a set of three (3) large diameter polyurethane rollers equipped with sealed preloaded ball bearings. Each roller shall be supported by a pivoted rocker



arm that shall automatically adjust itself to guide rail misalignment and prevent excessive lateral car movement.

- D. **Suspension Means:** If steel core ropes are supplied, a means to provide constant lubrication shall be provided. If rubberized steel belts are utilized as the suspension means, the monitoring device utilized to monitor the condition of the suspension means shall be installed and be the property of the Owner as well as any diagnostic, troubleshooting, or adjustment tools required or associated with the monitoring device. Suspension means shall be designed for ASME A17.1 rated load requirements.
- E. **Deflector Sheaves:** Provide machined and grooved sheave for diameter of ropes. All bearings are to be shielded or sealed. Provide resilient isolation materials including isolating grommets and washers at hold down
- F. **Stop Switch:** An enclosed stop switch, mounted in the pit (in a NEMA 4 rated enclosure for the elevator at the station that serves the platform) of each elevator in accordance with Rule 2.2.6 of the Code, shall prevent operation of elevator when switch is activated. Switch shall be of the type described in Rule 2.2.6 of the Code.
- G. **Emergency Auxiliary Stop Switch:** An enclosed stop switch, mounted in the over-head machine area and/or on the machine of each elevator in accordance with Rule 2.7 of the Code, shall prevent operation of elevator when switch is activated. Switch shall be of the type described in Rule 2.7 of the Code.
- H. **Dead End Hitch Assemblies:** Provide dead end hitch assemblies in accordance with engineered loading requirements.
- I. **Counterweight:** Counterweights shall consist of a steel frame welded or bolted together and necessary steel weight sections. These weight sections shall be held securely in place within the frame. A minimum of two (2)-tie rods shall pass through the holes in all weight sections. Submit paint finish of counterweights for approval. Paint color selection to be determined by the Program/Project Manager.
 - 1. A required counterweight screen where no compensation is used.
 - 2. The bottom of the counterweight shall have a buffer striking plate and means to attach knock-off blocks during rope stretch.
- J. **Idler Sheave:** To be located directly above the counterweight frame and integral with counterweight frame. The sheave material shall be accurately machined of semi-steel of hardness BHN 220-250 or as per manufacturer's requirements.



- K. Governor: Friction type over-speed self-resetting governor rated for the duty of the elevator specified and to operate the car safety. The finish of pit tension sheave shall be factory paint.
 - 1. Locate the governor where the car or the counterweight in case of over-travel cannot strike it, and where there is adequate space for full movement of governor parts.
 - 2. An electrical governor over-speed protective switch that, where operated, shall remove power from the driving machine motor and brake before or at the time of application of the safety.
 - 3. Seal and tag the governor with the running speed, tripping speed, and date last tested as required by Code.
 - 4. Operation/rest of the governor shall not require the installation of an overhead access panel. Status of the governor shall be capable of being monitored remotely at the elevator controller. A mechanical means to secure the car at the top of the hoistway while performing testing of the governor shall be provided.
 - 5. Location of elevator, direction of travel and movement of elevator car shall be capable of being monitored remotely. Emergency Rescue operation shall not require the use of an overhead access panel.
- L. Tension Sheave: Provide tension sheave in accordance with OEM's governor and car safety loading requirements.
- M. Terminal Limits: Limit switches shall slowdown and stop the car at the terminals if the primary automatic stopping system fails.
- N. Life Safety Provisions: Life safety hooks and/or other life safety devices for fall protection to be in accordance with OSHA standards/guidelines. Life safety hook and/or other life safety devices locations to be coordinated and installed by the Installer.
- O. Pit Ladder: Provide new Code compliant pit ladder.

2.08 MACHINE COMPONENTS:

- A. General: Provide equipment to fit into elevator hoistways as per the Contract Drawings. Hoistway dimensions as shown are firm and cannot be changed to accommodate therefore the installer must provide equipment that will fit within the dimensions shown.
- B. Machine: AC gearless machine, with permanent magnet synchronous motor, direct current electromechanical disc brakes and integral traction drive sheave. Machine to be mounted to the car guide rail or support beam mounted at the top of the hoistway. Machines are to be mounted in proper alignment on isolated bedplate utilizing resilient isolation material. Bolts utilized for seismic



restraint of the hoist machines shall not short-circuit the resilient isolation material.

C. Motor:

1. The motors shall be of the alternating current reversible asynchronous or synchronous type of a design adapted to the severe requirements of elevator service. Motor shall be capable of developing the torque required to meet or exceed an acceleration rate of 2 ft/sec² for the elevator car.
2. A means to protect the windings and bearings from airborne dust shall be provided.
3. Insulation of all windings shall be impregnated and baked to prevent absorption of moisture and oil. The insulation resistance between motor frame and windings shall not be less than one meg-ohm. The motor windings shall stand a dielectric test of twice the normal voltage plus 1000 RMS volts of 60 Hertz, alternating current for one minute.
4. Motor leads in the conduit box shall have the same insulation class as the windings. Motor lead wire shall be rated 125 C and shall be sized for 105 C at the motor nameplate amperes at 1.0 Power Factor per Electrical Apparatus Service Association (EASA) recommendations. Leads are to be numbered for clockwise rotation when facing opposite the shaft end.
5. The motor shall be designed to stand the severe loads encountered in elevator service and the windings shall have a minimum insulation temperature rating two ratings higher than the actual temperature rise of the motor, with a minimum rating of NEMA class F.
6. The motor shall be designed to the ASME A17.1 rated load requirements.

D. Brake:

1. Provide dual brakes that shall be of the self-adjusting fail-safe (spring applied and electrically released) type provided with a remotely operated, in the controller room, manual brake release and designed to meet the service factor demand of its intended use. Access panels at the top of hoistway shall not be required. Dual brakes shall operate independent of each other for ascending car overspeed and unintended car movement. Disc type brake shall be securely mounted to the shaft and shall run concentric to the shaft. Disc shall be machined to obtain a smooth and accurate face. The brake shall be spring actuated, direct current, electrically released, heavy construction with proper braking area for the load and speed specified. The brake shall be provided with sufficient power to stop and hold the car with full contract load. Disc brakes shall be of caliper or multiple disc design. car over speed and unintended car movement. Provide operation to prevent the elevator from striking the hoistway overhead or unintended car movement per the requirements of code

E. Drive and Deflector Sheave:



1. Sheave: The sheave material shall be accurately machined of semi-steel of hardness BHN 220-250. It shall be firmly pressed onto its shaft.

F. Mounting:

2.09 ANTI-VIBRATION MOUNTS: FOR MACHINES THAT ARE SUPPORT BEAM MOUNTED, AN ANTI-VIBRATION MOUNTING PAD IS TO BE PROVIDED. MACHINE TO BE MOUNTED TO THE CAR GUIDE RAIL OR SUPPORT BEAM MOUNTED AT THE TOP OF THE HOISTWAY. MACHINES ARE TO BE MOUNTED IN PROPER ALIGNMENT ON ISOLATED BEDPLATE UTILIZING RESILIENT ISOLATION MATERIAL. BOLTS UTILIZED FOR SEISMIC RESTRAINT OF THE HOIST MACHINES SHALL NOT SHORT-CIRCUIT THE RESILIENT ISOLATION MATERIAL. THE MACHINE BEAMS SHALL BE MOUNTED ON VIBRATION ISOLATION PADS. ELEVATOR DRIVE SYSTEMS

- A. Fully Regenerative AC Variable Voltage Variable Frequency (VVVF) Motor Drive: Provide fully regenerative drive as required to absorb regenerative power generated by the elevator system. Resistor banks to absorb energy are not permitted.
1. The drive shall be capable of varying the torque on the motor during acceleration and deceleration.
 2. The drive shall be capable of on-site programming the volts per Hertz, acceleration and deceleration ride profiles to adjust the ride quality due to drive control characteristics.
 3. The drive shall control AC induction motors through the use of a high resolution, dual channel optical encoder.
 4. The drive shall be capable of delivering 100% rated motor torque from base speed down to zero speed.
 5. The drive shall not use DC injection for slowdown braking.
 6. The drive shall be adjustable to achieve the required current, motor voltage and frequency so as to match the characteristics of the hoist motor.
 7. The drive shall not create excessive audible noise in the elevator motor.
 8. The drive shall be capable of delivering sufficient current to accelerate the elevator to contract speed at the rated load. The drive shall provide speed regulation within 5% during all phases of acceleration, deceleration and leveling.
 9. A contactor shall disconnect the hoist motor from the drive's output each time the elevator stops. If the contactor has not returned to the de-energized state when the elevator stops, the elevator shall not restart.
 10. Maximum total harmonic distortion shall not exceed IEEE Std. 519 to be measured at the elevator disconnect.
 11. The drive shall be housed in a NEMA 2 rated enclosure. If the drive is remotely located so as to require that a signal repeater be installed, installer shall properly locate and install taking into account the site constraints and in accordance with code requirements.



12. The cabinets containing the drives, if separate from the controller cabinet, shall be mounted on neoprene pads equivalent to Mason Industries Type 'W', with hold down bolts and grommets to provide seismic restraint and to avoid short circuiting the isolators.
13. Drives shall be either of the following:
 - a. KEB
 - b. Magnetek
 - c. OEM drive

2.10 SAFETIES

- A. General: A governor actuated mechanical safety device mounted under the car platform and securely bolted to the car sling.
 1. When tripped, the safety mechanism shall engage the rails with sufficient force to stop a fully loaded car with an average rate of retardation within limits given by the ASME A17.1 Code for the capacity.
 2. Make provisions to release the car safety. In no event shall the safety be released by downward motion of the car. Raising the car to reset the safety shall be allowed.
 3. Include an electrical safety plank switch that will interrupt the power to the hoist machine when the safety is set. Resetting the plank switch shall be separate from resetting the safety jaws.
 4. Install a car safety marking plate of corrosion resistant metal showing the data required by the Code.

2.11 CONTROLLER:

- A. General:
 1. The elevator control equipment shall contain diagnostic capabilities as required for the ease of complete maintenance. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the service person and the controls. All such systems shall be free from decaying circuits that must be periodically reprogrammed by the manufacturer.
 2. Switch gear shall be mounted in NEMA 2 stainless steel cabinets and labeled terminal strips.
 3. The main controller shall be microprocessor based controller manufactured by the Vendor capable of being tied to the Lift Net remote monitoring system. Items/Specifics to be monitored to be determined by the Owner and Program/Project Manager.
 4. The Controller shall be provided, governing starting and stopping, as well as preventing, damage to the motor from overload or excessive current. It shall automatically cut off the motor current and bring the car to rest in the event any of the safety devices are activated. The controller shall be mounted in a vented cabinet within the machine room. The controller shall utilize soft start characteristics.



5. Selective Collective Operation: As defined by ASME A17.1.
6. Provide intermittent automatic operation, once every 3 hours through the entire run of the hoistway. Cycling shall be the full 24 hours each day throughout the year.
7. The controller shall be capable of being remotely located in a location that is not adjacent to the hoistway and within 150 linear feet from the elevator machine location. If the location of the controller and drive require that a signal repeater be installed, elevator installer must properly locate in accordance with site constraints and in compliance with code requirements.
8. The controller cabinet shall be floor mounted on neoprene vibration isolation pads, with no rigid contact between the cabinets and the walls.
9. Installer shall provide a dielectric/non-conductive floor mat in front of each controller.

- B. Remote Monitoring System: The Lift Net remote monitoring system shall be provided by the installer and all elevators shall be connected to this system. The Installer is responsible for providing all provisions necessary for connecting the elevators to the Lift Net system. The elevators may be connected via Wi-Fi or Ethernet. This is to be coordinated with PSHIA IT Department.

2.12 HOISTWAY ENTRANCES

- A. General:
1. Hoistway entrances shall be of the horizontal sliding type, with operation and number of panels as indicated on the Contract Documents.
 2. All materials and finished surfaces exposed to public view shall be as indicated on Contract Documents.
- B. Hoistway Frames and Doors:
1. Entrance frames shall be of welded and mitered construction for complete one-piece unit assembly. All frames shall be sound deadened and securely fastened to fixing angles mounted in the hoistway.
 2. Entrance frames shall be provided with an extended sill floor plate the full width and depth of each entrance frame assembly.
 3. Hoistway entrances shall be of the horizontal sliding type, with operation and number of panels as indicated on the Contract Documents.
 4. Hoistway doors shall be reinforced and provided with keyways as required for operating mechanisms and door hangers. Door panels shall be hollow metal flush door construction, 16-gauge furniture steel. Fill with fireproof, sound deadening material. Provide reinforcement by formed vertical sections running full height of door. Panels front and rear, framing, operating levers, and integral hardware shall be type 316 stainless steel; panel shall be 2 mm and have finish as indicated on Contract Documents. Door shall be provided with door gibs, quantity as required for proper



- operation and to meet Code, and shall be SEES Enforcer or approved equal. Guides are to be replaceable without removing door panels.
5. Provide die cast jamb markings (2 per entrance) mounted at 5'-0".
 6. Hoistway door hangers and door operator shall be as specified herein.
 7. Hoistway door rollers are to utilize polypropylene material for wearing surface.
 8. Finishes coordinated with the Architect.
 9. Sight guards shall be type 304 stainless steel.
- C. Struts and Closer Support Angles: Hoistway entrances adjacent to non-load bearing walls (gypsum dry wall, gypsum block, etc.) shall have hanger housing and door closers supported by steel angles of adequate size. Angles shall be continuous between sill and building beams above and shall be bolted to the hanger support. For load bearing walls (masonry, concrete block), submit for Program/Project Manager's approval Shop Drawings of the method to be used to support hanger housing and door closers on the wall.
- D. Landing Sills: Landing sills shall conform to Rule 2.11 of the Code and shall be nickel silver sills supplied with grooves and trash slots for door guides and machine planed for minimum clearance. Mount sills on combination of concrete/grout and steel supports anchored to floor construction.
- E. Hanger Supports and Cover Plates: Hanger supports shall be T bolted to strut angles and closer support angles. Hanger cover plates shall be nominal 14-gauge Type 304 stainless steel minimum and shall extend, as indicated in the contract documents. Covers shall be made in sections for convenient access when servicing hangers. Hanger sections above door openings shall be removable from within elevator car.
- F. Dust Cover: Shall be Type 304 stainless steel. Dust cover shall be reinforced as necessary to ensure a flat even surface throughout. Dust cover shall extend at least the full width of door opening on each side and fastened to hanger housings. Dust cover shall extend above entrance opening as indicated on Contract documents.
- G. Interlocks and Contacts:
1. The doors at each hoistway entrance shall be equipped with approved hoistway door interlocks of the hoistway unit system type tested as required by the Code.
 2. Interlock shall prevent operation of the car away from a landing until doors are locked in the closed position. Interlock shall prevent doors from opening at any landing from the corridor side unless car is at rest at that landing, or is in the leveling zone and stopping at that landing.
 3. Hoistway door unlocking devices shall conform to the requirements of the Code and shall be provided to permit authorized persons to gain access to



- hoistway when car is away from landing. Ferrules shall be supplied for all hoistway unlocking device keyholes to protect elevator hoistway doors.
4. Provide an electric contact mounted on the car that will prevent the car from moving away from landing unless car doors are closed.

- H. All Hoistway Fascia Panels shall be stainless steel of thickness and construction to meet requirements of the Code in regard to strength and deflection.

2.13 CAB ENCLOSURE COMPONENTS

A. General:

1. Elevator car and car components shall meet the applicable requirements of the Code. Car operating stations, position indicators, riding lanterns shall be per PSHIA Standard. Engraving shall be coordinated with the Owner.
2. Entire car assembly, including car frame and platform, shall be free from warps, buckles, and squeaks and rattles. Joints shall be lightproof.

B. Car Frame and Platform:

1. Car frame and platform shall be welded galvanized steel units designed and fabricated in accordance with applicable requirements herein and shall meet APTA loading requirements.
2. Protect car platform with fire retardant material. The platform shall be recessed as required to accept floor finish. Floor finish shall be epoxy terrazzo coordinated with the Architect and installed by others.
3. Sub floor shall be suitably reinforced to support live loads of the elevator cab and shall be of stainless steel plate construction.
4. Floor covering for platform shall be 3/8" thick epoxy matrix thin-set terrazzo on a flexible epoxy crack suppression membrane. Substrate shall be exterior grade plywood – 3/4" minimum thickness. Color to be selected by the Architect. Flooring to be installed by others.

C. Car Enclosures:

1. Car top shall be of stretcher leveled, cabinet grade, and nominal 0.104" thick furniture sheet steel, reinforced to support 300 pounds on any one square foot area. An emergency exit shall be installed in the car top in conformance with the Code. Interior surface of car top shall be painted reflective white. Exterior surface of car top shall be painted black. (NEW)
2. Ventilation: 3-speed exhaust fan. Finish and material of fan enclosure and blade shall match the finish and material of the ceiling. Exhaust blowers shall be designed with a hood.
3. Size and detail to withstand design stresses and provide for attachment and support of cladding, housing, ceiling, glass panels, and appurtenances. Paint all members after fabrication.



4. Suspended Ceiling: to be coordinated with Architect and Program/Project Manager for type and finish.
5. Interior Walls: to be coordinated with Architect and Program/Project Manager for type and finish.
6. Cab Walls shall have sound deadening.
7. Fixed Front Return Panels: to be coordinated with Architect and Program/Project Manager for finish.
8. Car Doors: Car doors to be supplied as indicated in the Contract Documents. Doors shall protect the full width and height of car entrance opening when in the fully closed position. Car doorframe shall be integral with front wall of cab.
9. Handrails / Bumper Rails: to be coordinated with the Architect and Program/Project Manager for type, finish, and location.

D. Car Door Equipment:

1. Door Hangers: Door hangers for car and hoistway doors shall be of the two-point suspension sheave type equipped with grease packed heavy duty precision ball bearings, eccentric up-thrust rollers, and oiler/cleaners. Track shall be of formed cold rolled steel or cold drawn steel with rounded track surface to receive sheaves. Track shall be mounted on an eccentric stud to provide for adjustment. Rollers shall have polypropylene material for wearing surface.

E. Toe Guard:

1. Provide forty-eight (48) inch toe guard.

F. Top of car railings: Provide where required to meet Code requirements.

2.14 SIGNAL DEVICES AND FIXTURES

- A. General: Provide signal fixtures and control devices for each elevator. Buttons and signals shall be tamper resistant of the illuminated type that light-up when activated and remain lit until call or other function has been fulfilled. All signal fixture and control devices shall be nominal 0.135 inch thick, unless otherwise shown on the Contract Documents. Design to be per PSHIA Standards and as modified by these specifications. It's design, including all engraving and custom features are to be coordinated with the Owner, Architect and Program/Project Manager.

B. Car Operating Station:

1. Provide one (1) main station and one (1) auxiliary station for all elevators in the front returns of the passenger elevators. Car operating stations shall be supplied with hinges that are inconspicuous when installed.
2. Car operating station shall have engravings and Braille that spell out landings served adjacent to each call button. Contractor to coordinate proper landing call outs based on maximum characters as indicated on



Contract drawings. Buttons for DOOR-OPEN, DOOR-CLOSE, ALARM, EMERGENCY PHONE call functions are to be supplied. Buttons are to be vandal resistant and of the positive stop type.

3. Station shall also have keyed switches for car light operation, ventilation, inspection, independent service, and any other keyed functions as directed by the Owner and Program/Project Manager and be located within a lockable compartment
4. Engrave the car operating panel as coordinated with Owner, Architect and Program/Project Manager.
5. Provide engraved raised markings for the car buttons and car controls in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1.
6. Emergency Communication: per PSHIA Standards.
7. Fixtures shall be free of any manufacturer identification.
8. Fixtures shall have Voice Annunciation.
9. Main Car Operating Panel shall incorporate an elevator display that shall be customizable. Customization and graphics shall be coordinated with the Owner and Architect. The elevator display shall be Model EMN70-AHX as manufactured by C.E. Electronics.
10. Fixtures shall be factory pre-wired for ease of installation.
11. Floor Name Inserts (without Braille) are to be provided to the right of the Car Call Pushbuttons. Floor Names are to be coordinated with the Owner, Architect and Program/Project Manager. Level Number (with Braille) inserts are to be provided to the left of the Car Call Pushbuttons.

- C. Top of Car Operation Device: Provide a top-of-car operating device in compliance with the Code. The device shall have control switches for UP, DOWN, OPERATE/INSPECT and EMERGENCY STOP. The device shall also have an 110v ac outlet for extension cord and provided with a light and guard.
1. Top of Car Operating Device shall have integral emergency LED light that illuminates in the event of power loss.

- D. Hall Stations: Hall stations of the push-button, call acknowledging, stainless recess mounted into the wall and or returns at all elevator landings.
1. Buttons are to be vandal resistant and of the positive stop type. They are to be installed in water tight enclosures at all exterior locations.
 2. Highest landing shall have a single DOWN button. Lowest landing shall have a single UP button. Intermediate landings shall have UP and DOWN buttons with the Up button on top.
 3. Provide die cast raised markings for the hall buttons in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1. Die cast plates are to be flush with faceplate surface. They shall show the words, Up and Down on the plates.
 4. Engrave the hall station with the following:
 - a. In Case of Fire Do Not Use Elevator.
 - b. Firefighters Operating Instructions.



- c. Emergency Power indication.
 - d. Communications Failure indication.
- E. Hall Lanterns:
 - 1. Tamper resistant hall lanterns shall be equipped with illuminated UP and DOWN signal arrows. Provide units projecting from faceplate for ease of angular viewing.
 - 2. In conjunction with each hall lantern, provide an adjustable electronic chime signal to indicate that a car is arriving in response to a hall call and to indicate direction of car travel. Signal shall sound one for up direction of travel and twice for the down direction.
 - 3. Hall Lanterns shall incorporate a Digital P.I. as manufactured by C.E. Electronics.
- F. Firefighters Service: Firefighters' service system shall be provided in compliance with national and local code requirements. Keys shall be AZFS standard.
- G. Hoistway Access: key switches shall be installed at the uppermost and lowest landings as per Code requirements. They are to be NEMA 4 rated.
- H. Provide two-way communication between car and machine room if required by Code.
- I. Bell Alarm System: Bell alarm system for each elevator shall be properly located within building and audible outside hoistway when activated by the Emergency Stop switch or Alarm call button on each car control station.
- J. Machine Room Monitors: Provide a monitor in each machine room capable of displaying status, position and critical items for troubleshooting of equipment.
- K. Provide installation assistance and provision for ACAM card readers and security features, where applicable, within the elevator cab.

2.15 OPERATION:

- A. General: Operation shall be selective collective.
 - 1. Operation shall be automatic by means of the car and landing buttons. Stops registered by the momentary actuation of the car or landing buttons shall be made in the order in which the landings are reached in each direction of travel after the buttons have been actuated. All stops shall be subject to the respective car or landing button being actuated sufficiently in advance of the arrival of the car at that landing to enable the stop to be made. The first car or landing button actuated shall establish the direction of travel for an idle car.
 - 2. "UP" landing calls shall be answered while the car is traveling in the up direction and "DOWN" landing calls shall be answered while the car is



traveling down. The car shall reverse after the uppermost or lowermost car or landing calls has been answered, and proceed to answer car calls and landing calls registered in the opposite direction of travel.

3. If the car without registered car calls arrives at a floor where both up and down hall calls are registered, it shall initially respond to the hall call in the direction that the car was traveling. If no car call or hall call is registered for further travel in that direction, the car shall close its doors and immediately reopen them in response to the hall call in the opposite direction. Direction lanterns, if provided, shall indicate the changed direction when the doors reopen.

- B. Independent Service: Provide a key switch in the car operating panel which, when actuated, shall cancel previously registered car calls, disconnect the elevator from the hall buttons and allow operation from the car buttons only.
- C. Automatic Leveling: Machine room less gearless machine/motor design shall be coordinated with the control so that car shall slow down and stop automatically at the floor (within 1/4 inch) after transition from contract speed. Car level shall be maintained automatically within one-quarter inch of the landing by an anti-creep leveling device regardless of any deviation that maybe caused by the loading or unloading of the car. Landing zone detection shall indicate to the control system the position with respect to the floor level.
- D. Other Items:
 1. Load Weighing: Provide means for weighing car passenger load. Control system to provide dispatching at main floor in advance of normal intervals when car fills to capacity. Provide hall call by-pass when the car is filled to preset percentage of rated capacity and traveling in down direction. Adjustment range: 10% to 100%
 2. Anti-Nuisance Feature: If weight in car is not commensurate with number of registered car calls, cancel car calls. Systems employing either load weighing or door protective device for activation of this feature are acceptable.
 3. Earthquake Operation: to meet Seismic Zone 2 requirements.
 4. Fan and Light Output Timer: Provide an adjustable timer (Range 1 to 10 minutes) that when activated will turn off the fan and light within the car. The timer will start when the car becomes inactive.
 5. Emergency Power Requirements: Provide emergency power provisions in accordance with code requirements for all elevators.
 6. Home Floor Function: Elevators shall be capable of having a pre-set home floor where the elevator will automatically return to when no demand is present.

2.16 WIRING AND ELECTRICAL INSTALLATION:

- A. Conduit and Wiring:



1. Unless otherwise specified, all electrical conductors in the pits and hoistways, except traveling cable connections to the car shall be provided in rigid galvanized steel conduit with steel outlet boxes, except that a small amount of flexible conduit may be used where conduit is not subject to moisture or embedded in concrete.
2. Rigid steel conduit shall be full weight, threaded, galvanized, inside enameled, conforming to ANSI C80.1.
3. Terminal boxes and other similar items shall be of approved construction, thoroughly reinforced, and in no case less than number 12 USSG and shall meet ANSI/NEMA FB 1.
4. All electrical boxes exceeding 150 cubic inches shall be supported independently of the conduits. The rigid conduit shall conform to the specifications here in before specified. All raceway shall be threaded rigid galvanized steel conduit complying with ANSI/NEMA FB 1.
5. Where permitted flexible heavy-duty service cord, type SO, may be used between fixed car wiring and switches on car doors for door reversal devices.
6. Where permitted, flexible metal conduit shall be fabricated in continuous length from galvanized steel strip, spirally wound and formed to provide an interlocking design with a gray XLPO Thermoset Type 2 outer jacket.
7. All conduits terminating in steel cabinets, junction boxes, wire-ways, switch boxes, outlet boxes and similar locations shall have approved insulation bushings. If the bushings are constructed completely of insulation material, a steel locknut shall be installed under the bushing. At ends of conduits not terminating in steel cabinets or boxes, the conductors shall be protected by terminal fittings having an insulated opening for the conductors.
8. All conduits terminating in a NEMA 4X boxes shall be backed up with flat rust resistant steel plates to fit the entire area where the conduit penetrated the box.
9. Conduit fittings and connections shall be compression type. The use of set screws or indentations as a means of attachment is not permitted.
10. Connect motors and other components subject to movement or vibration, to the conduit systems with flexible conduit.
11. The Contractor shall furnish all materials and completely wire all parts of the electrical equipment of the elevators including electrical devices on hatch doors. All car wiring and conduit shall be replaced with new including car junction boxes.
12. Conduits shall be brought and connected to suitable approved connection boxes at all outlets, apparatus and panels.
13. Conduit Sizing, Arrangement, and Support
 - a. Size conduit per NEC for conductor type installed or for Type THW conductors, whichever is larger; 3/4-inch minimum size for conduit.
 - b. Conduits for small devices such as door switches, interlocks, etc. shall be permitted at ½ inch.



- c. The total overall cross-sectional area of the wires contained in any conduit shall not exceed 40 percent of the internal area of the conduit.
 - d. Arrange conduit to maintain headroom and present a neat appearance.
 - e. Route exposed conduit parallel and perpendicular to walls and adjacent piping.
 - f. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
 - g. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
 - h. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit on racks.
 - i. Do not fasten conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
 - j. No conduit shall be attached to a cable tray or installed within 6 inches of a cable tray or light fitting except for termination.
 - k. Approved strain boxes shall be installed for all vertical runs in accordance with Code.
14. Where conduit penetrates fire-rated walls and floors, seal opening around conduit with UL listed through penetration fire-stop system to maintain wall or floor rating.
15. All interlock, hall button and limit switch branch wiring shall be enclosed in flexible steel conduit with covering of liquid tight Type "EF" with connectors having nylon insulated throat.
16. All screws used for terminal connections of all wiring (machine room, hoistway and pit) shall be provided with "star washers" of proper size and type.

B. Conductors:

- 1. Unless otherwise specified, conductors, exclusive of traveling cables, shall be 98% conductivity copper, solid, for size 10 AWG and smaller, and stranded for size 8 AWG and larger shall be stranded or solid coated annealed copper in accordance with the NEC for Type THHW.
- 2. Where 16 and 18 AWG are permitted by Code, either single conductor cable in accordance with Code for Type TF, or multiple conductor cable may be used provided the insulation of single conductor cable and outer jacket of multiple conductor cable is flame retardant and moisture resistant.
- 3. Insulation Voltage Rating: 600 volts.
- 4. Insulation: ANSI/NFPA 70, type THHN/THWN, XHHW or THW.



5. The use of PVC insulation shall not be permitted.
6. Multiple conductor cable shall have color coding or other suitable identification for each conductor. Conductors for control boards shall be in accordance with Code.
7. No joints or splices shall be permitted in wiring except at outlets. Tap connectors may be used in wireways provided they meet all UL requirements.
8. All wiring shall test free from short circuits or grounds. Insulation resistance between individual external conductors and between conductors and ground shall be not less than one meg-ohm.
9. Where size of conductors is not given, capacity shall be such that maximum current shall not exceed limits prescribed by Code.
10. Equipment grounding shall be furnished and installed. Ground conduits, supports, controller enclosures, motors, platform and car frames, and all other non-current conducting metal enclosures for electrical equipment in accordance with Code. The ground wires shall be copper, green, insulated and sized as required.
11. Terminal connections for all conductors used for external wiring between various items of elevator equipment shall be solderless pressure wire connectors in accordance with Code. The Contractor may at his option make these terminal connections on No. 10 or smaller conductors with approved terminal eyelets set on the conductor with a special setting tool, or with an approved pressure type terminal block. Terminal blocks using pierce-through serrated washers are not acceptable.
12. Provide all necessary conduit and wiring between all remote machine room and hoistway.
13. Color Coding: All power conductors identified as to phase and voltage by means of color impregnated insulation, as follows:

Voltage	ØA	ØB	ØC	Neutral	Ground
120/208V	Black	Red	Blue	White	Green
277/480V	Brown	Orange	Yellow	White	Green

For wire sizes No. 8 AWG and larger, color banding tape, minimum 2 inches wide, may be used at all accessible locations in lieu of colored insulation.

C. Traveling Cables:

1. Traveling cables from junction box on car to junction box in hoistway shall consist of flexible traveling cables conforming to the requirements of Code.
2. Junction boxes in hoistway and on car shall be equipped with terminal blocks. All connections to terminal blocks shall be made with either terminal eyelet connections or pressure wire connectors of the clamp type that meet UL 486 requirements for stranded wire.



3. Terminal blocks shall have permanent indelible identifying numbers for each connection. The outer covering must remain intact between junction boxes. Abrupt bending or twisting producing distortion of cable is not permitted.
4. Cables shall be free from any possible contact with hoistway structure, car or other equipment. Furnish and install shields or pads to protect the cables.
5. Provide 10 percent spares, but not less than 6 spare conductors in each traveling cable
6. Provide two (2) spare CCTV wires and twelve (12) shielded pairs of Type ETT/300V as manufactured by Draka Elevator Products, SuperFlex WSCC 14X18SH or approved equal for IT/Data, security and telephone systems.
7. Provide separate traveling cables for car lighting and fan control circuits.
8. Provide traveling cable for telephone in the elevator car. Cable shall extend from junction box in hoistway to telephone box in car.
9. Provide traveling cable for car work lights. Cable shall extend from junction box in hoistway to car junction box.
10. Car and hoistway junction boxes shall be provided for on the top of the elevator cab.
11. Cables shall include ten percent spare wires between each controller, selector, and hoistway junction box, all spares to be properly tagged or otherwise identified with clear and indelible markings.
12. All insulated wiring, control wiring and wiring in traveling cables shall be tag coded at their terminals in the motor room or controller location and hoistway junction box, elevator cab junction box, and push-button stations within the cab, and shall agree with the approved wiring diagrams.
13. The traveling cable shall be wired directly from the controller to the elevator with no hoistway junction box.

D. Motor Circuits

1. Contacts in elevator motor circuits that are to be opened by governors or other safety devices shall be copper to carbon or other approved of the non-fusing type. Contacts on control and signal relays and switches shall be commercially pure silver. Contacts on switches breaking heavy motor circuits shall be copper to carbon or, if of metal, shall have supplementary breaking contacts and shall operate with suitable wiping action, or shall be of approved equivalent design and construction. They shall be equipped with suitable blowout coils, vanes, barriers, etc., where necessary to prevent undue arcing and heating.

E. Car and hall operating signal circuits shall be not exceeding 48 volts.

F. Each major component of equipment shall have the manufacturer's name, type, class or catalog number on a metal plate securely attached to the item of equipment in a conspicuous location.



- G. All cabinets containing motor drives, filter boxes, transformers and power reactors shall be supported on rails and isolated from the base building structure with elastomer pads having a minimum static deflection of 3/8" (Mason Type N, or equivalent). All connections to and from the cabinetry shall be flexible in order not to compromise the isolation system. Use non-rigid conduit for the final electrical connection, with all other conduit supports and clamps provided on a neoprene sponge insert.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to commencing with the installation of elevator equipment, examine the following and verify that no irregularities exist that would affect the quality of execution of work specified. Physically verify all dimensions. It is important to note that the elevator spaces will be constructed as shown on the Contract Drawings and no modifications will be permitted to accommodate the equipment. Therefore, the installer must provide equipment that will be suitable for the space provided.
 - 1. Controller room size and location
 - 2. Hoistway size and Plumbness
 - 3. Anchor brackets
 - 4. Sill Support
 - 5. Pit depth
 - 6. Overhead clearance

3.02 INSTALLATION

- A. Install elevator in accordance with the OEM's installation procedures and approved Shop Documents. Install equipment so it may be easily removed for maintenance and repair. Install all equipment to afford maximum accessibility, safety, and continuity of operation.
- B. All elevator equipment including their supports and fastenings to the building, shall be mechanically isolated from the building structure and main line power feeders to minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of the building.
- C. Verify that electrical wiring installation is in accordance with the OEM's submittal.
- D. Erect all items square, plumb, straight and accurately fitted with tight joints and intersections.
- E. Coordinate with the Contractor to ensure that the installation of the elevators is not in conflict with the work performed of other trades.



- F. Isolate non-compatible, dissimilar materials from each other by providing vibration isolation, gaskets or insulating compounds.
- G. Provide protective coverings for finished surfaces.
- H. Upon completion, touch up and restore damaged or defaced factory finished surfaces.
- I. Touch up any marred finishes and replace as directed by the Program/Project Manager.
- J. Remove protective coverings and clean exposed surfaces after completion.
- K. Welding shall comply with AWS D1.1. Identify field welds with welder's identification stamp.
- L. Installer shall provide all special tools to the Owner, including elevator adjuster's laptop at completion of installation.
- M. Elevators will be periodically inspected during the installation process by the Program/Project Manager and Owner/Owner's Representative. All requests made by the inspecting personnel are to be addressed by the installer to the satisfaction of the inspecting personnel.

3.03 FIELD TESTING

- A. General: After installation, the Installer shall inspect and test each elevator and related equipment to the Program/Project Manager and Owner's satisfaction that operation of every part of the equipment complies with this specification and with applicable requirements of ASME/ANSI A17.1 including ride quality, performance, and sound level criteria specified herein. Elevator will be inspected in accordance with the following:
 - 1. Installer shall notify the Owner seven (7) days prior to each scheduled test. Installer shall perform testing in the presence of an Owner representative and the Program/Project Manager. The test will include the functionality of the remote monitoring system and verification that all monitored items are being monitored by Lift Net. The test is in addition to those performed by the Authority Having Jurisdiction.
 - 2. Installer shall notify the appropriate local authorities having jurisdiction a minimum of seven (7) days in advance of final acceptance tests.
 - 3. Installer shall provide all instruments, materials, and labor required for tests specified herein.
- B. Acceptance Testing:
 - 1. After installation and before date approved for start of warranty period, inspect and test the elevator and related equipment to the Program/Project Manager's and Owner's satisfaction that operation of



every part of equipment complies with applicable requirements of ASME/ANSI A17.1 and local codes along with requirements of the contract specifications. Elevator shall be inspected in accordance with procedures outlined ANSI/ASME A17.2. This inspection and testing is in addition to any inspections and tests performed in the presence of the authority having jurisdiction.

- C. Notification Requirements: Notify the Program/Project Manager a minimum of five (5) working days prior to each scheduled test.
- D. Full Load Run Test: Run elevator continuously a minimum of four (4) hours with full specified rated load, during which time car shall be stopped at top and bottom landings with a minimum standing period of ten (10) seconds at each landing.
- E. Speed Test: Make tests before, during and after full load tests. Using a tachometer on guide rail, determine actual speed of car in both directions of travel, both with full-specified rated load and no load in car. Tolerances for determining if car speeds meet the specified requirements are as follows: Ascending and Descending Car Speed not more than 10 percent above or more than 10 percent below required speed.
- F. Car Leveling Test: Determine accuracy of floor landing tests both before and after full load run tests. Minimum of 1/4 inch leveling must be maintained. Test accuracy of landing at all floors with full load and no load in car, in both directions of travel.
- G. Electrical Tests: Ensure elevator wiring system is free of short circuits and accidental grounds. Test ground resistance of elevator structure, equipment, and raceways for continuity. Using meg-ohm-meter, determine that insulation resistance of each circuit is more than one (1) meg-ohm or higher as required by the cable manufacturer. Insulation resistance for motors shall be determined under actual conditions after installation.
- H. Acceptance: Elevator acceptance will be based upon elevators meeting requirements of Contract Documents, including training, and upon evidence of passing specified acceptance tests and inspections, completion of commissioning and verification that all punch list items have been addressed to the Owner's and Program/Project Manager's satisfaction.
- I. Test Reports: Within five (5) days after completion of a test, submit a test report stating type of test, test requirements, failures, or problems, and name of certifying Engineer and Title. Safety device failure or defective equipment shall be identified, with description of cause and corrective action taken.
- J. Failures for any reasons shall be identified with cause(s) and corrective action taken.



K. Retest Notification Requirements:

1. The Program/Project Manager shall be notified ten (10) days prior to the scheduled retest. If any equipment is found to be damaged or defective, or if performance of the elevator does not conform to the requirements of the contract specifications or the Safety Code, no approval or acceptance of elevators shall be issued until all defects have been corrected. When the repairs and adjustments have been completed and the discrepancies corrected, the Program/Project Manager shall be notified and the elevator will be re-inspected. Rejected elevators shall not be used until they have been re-inspected and approved.
2. The certificate of inspection for operational use will be issued to the Owner by the enforcing inspection agency. The certificate shall be posted in the elevator control room and in the car operating station.

3.04 ADJUSTING, CLEANING AND PAINTING

- A. All equipment shall be adjusted prior to final testing and acceptance.
- B. Restore all exposed work soiled or damaged during installation to its original finish. Repair to match adjoining work prior to final acceptance.
- C. Painting: The following equipment shall be clearly identified by number using four-inch stenciled numerals; crosshead, pit equipment, stop switches, and all machine room and secondary equipment (including but not limited to machines, controllers, drives). The pit equipment including rails shall be painted. The top of the elevator shall be completely cleaned and painted. Painting shall include the top of the cab, stiles, crosshead, and all other top of car related equipment. The machine area shall be completely cleaned and painted including the machine support steel and machine. The counterweight shall be cleaned and painted.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.





SECTION 14310

HEAVY-DUTY TRANSIT TYPE ESCALATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Design, fabrication, installation, testing and commissioning of APTA Heavy Duty Transit type escalators.
- B. Related Requirements:
 - 1. All contract documents in Package B04 (GMP-5).

1.02 GENERAL DESCRIPTION

- A. Provide all engineering, equipment, labor and permits required to satisfactorily complete design, fabrication, installation, testing and commissioning of four (4) heavy-duty transit escalators as required by contract documents at 24th Street Station.
- B. The Installer is to ensure that all work is performed in accordance with the requirements of local codes and regulations, which govern the requirements of the work specified. All equipment, design, clearances, construction, operation and tests are required to be in accordance with these specifications, the APTA Heavy Duty Transit Guidelines and the ASME/ANSI A17.1 - Safety Code for Elevators and Escalators and all pertinent codes, regulations and rules being enforced by the City of Phoenix Planning and Developmental Services.
- C. The Installer is required to perform thorough field surveys in addition to providing all engineering, labor, materials, storage, tools, equipment, supervision and transportation in order to fulfill the requirements for design, engineering, fabrication, and installation of the escalator equipment in a complete first-class manner and in accordance with the requirements of the contract documents.
- D. Whenever a reference is made to a part of the equipment being provided in a singular number, it applies to as many such items that may be required to provide a complete installation.
- E. Any equipment not specifically identified within the contract documents but that is essential to the installation and operation of the equipment specified herein is to be provided by the Installer as if the same was identified in the specification.



- F. Specifications indicate the arrangement of the escalator work to be provided. The Installer is to carefully review these documents along with field conditions and the overall design of the project, as the Installer will be responsible for the proper fitting and installation of the equipment specified. Installer is required to work closely with the Program/Project Manager.
- G. Installation of the new escalators includes, but is not limited to, the following:
 - 1. Installation of new heavy-duty escalators.
 - 2. Installation of flashing and closure elements required to coordinate new escalators with structural and architectural elements.
 - 3. Installation of truss cladding on all exposed sides, including the cladding beneath the escalator truss, to match finishes indicated on the contract documents.
- H. Provide all required staging, protection, hoisting, hoist/safety beams, and equipment necessary for the movement of equipment.
- I. Transportation and Handling: Materials, products and equipment shall be properly packaged and protected from damage during transportation, storage and handling. Coordinate delivery and movement of large items in Phoenix Sky Train facilities with the Engineer.
- J. Product Delivery, Storage and Handling:
 - 1. Deliver material in manufacturer's original, unopened protective packaging.
 - 2. Protect equipment and exposed finishes from damage and stains during transportation, erection and construction.
 - 3. Available storage space at the site is limited. Any additional off-site space required, including cost, is responsibility of the Vertical Transportation Equipment Supplier.
 - 4. Allocate available site storage areas and coordinate their use with the Engineer and the work of other contractors.
 - 5. Provide suitable temporary weather-tight storage facilities as may be required for materials that will be stored in the open.
- K. Installer is to provide any and all information as required for the appropriate coordination of work to be performed by other trades. Address any possible impacts on the installation schedule.
- L. Commissioning Requirements: Completion of the escalator work requires of the Installer to have the equipment completely inspected in accordance with the specifications in order to demonstrate that the equipment, as installed, conforms to the specifications and code requirements. All labor, tools and equipment necessary to conduct the onsite commissioning inspections and testing are the responsibility of the Installer. The commissioning inspections



and tests will be performed by the Program/Project Manager prior to the inspection by the City of Phoenix Elevator Inspector.

- M. The Installer has no advertising privileges related to this project unless specific written permission is obtained from the owner. Installer is required to maintain the work area free from any and all posters, signs and decorations. Installer's name, trademarks, logos or other identifying symbols are not to appear on any surface on the equipment visible to the general public.

1.03 DEFINITIONS

- A. Heavy-duty escalator: An escalator designed specifically for transit system usage. Substantially different from commercial units in the design of truss, machine, step chain, step chain tensioning device, steps, brake, and other components/equipment.
- B. Flat steps: Number of flat steps shall be measured from edge of combplate in horizontal direction to first exposure of a riser, at upper and lower landings.
- C. Working points: Points of intersection of step nosing line and the horizontal line of the top and bottom landing plates at finish elevation.
- D. Special tools: Tools designed specifically for tasks associated with escalator examinations, maintenance, and repair, or those which are required for these tasks and are not readily available through normal purchasing channels.
- E. Step width: The horizontal distance between skirt panels.
- F. Escalator support: These are the upper, lower, and intermediate supports needed to support the total loads of the escalator.
- G. Installer: The installer is the Contractor, or Subcontractor, responsible for furnishing and installing the escalators. For this Project, it will be the Vertical Transportation Equipment Supplier.
- H. Contractor: Any responsible party involved in the installation other than the installer of the escalators. For this Project, it will be considered the CM@Risk.
- I. Program/Project Manager: This is considered the Vertical Transportation Design Professional for the project. He will be responsible for design coordination, submittal review, construction support/inspection services and commissioning on behalf of the Owner.
- J. APTA – American Public Transit Association



1.04 TEMPORARY AND PERMANENT ELECTRICAL POWER SERVICES TO BE PROVIDED BY OTHERS

- A. For the escalator drive systems: 480 volts, 3-phase, 3-wire, 60 Hertz terminating in at a primary disconnect switch located in the new remote controller rooms and an auxiliary disconnect switch will be required in the upper escalator pit. Vertical Transportation Equipment Supplier must coordinate with the Contractor and the Program/Project Manager.
- B. For escalator lighting: 120 volts, 1-phase, 3-wire, 60 Hertz terminating at the escalator controller as a basis of design; however, Vertical Transportation Equipment Supplier must coordinate with the Contractor and the Program/Project Manager for specific requirements for lighting systems provided.
- C. For pit lighting and receptacles: 120 volts, 1-phase, 3-wire, 60 Hertz terminating at a disconnect switch in the upper escalator pit as a basis of design, however, Vertical Transportation Equipment Supplier must coordinate with the Contractor and Program/Project Manager.

1.05 APPLICABLE CODES, STANDARDS, AND PUBLICATIONS

- A. Escalator designs and installations: Heavy-duty, public transit service type in accordance with APTA standards and are to comply with the following:
 - 1. ASME A17.1 – Safety Code for Elevators and Escalators, applicable edition.
 - 2. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks; applicable edition.
 - 3. ASME A17.5 – Elevator and Escalator Electrical Equipment; applicable edition
 - 4. European Norm – EN 115
 - 5. Local Fire jurisdiction
 - 6. Life Safety Code, NFPA 101, and CCR Title 19
 - 7. Uniform Federal Accessibility Standard (UFAS)
 - 8. City of Phoenix Elevator Code
 - 9. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; applicable edition
 - 10. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; applicable edition
 - 11. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); applicable edition
 - 12. ASTM A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; applicable edition
 - 13. ASTM A 490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); applicable edition



14. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; applicable edition
 15. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; applicable edition
 16. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; applicable edition
 17. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar; applicable edition
 18. ASTM B 138/B 138M - Standard Specification for Manganese Bronze Rod, Bar, and Shapes; applicable edition
 19. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; applicable edition
 20. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); applicable edition
 21. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; applicable edition
 22. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); applicable edition
 23. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; applicable edition
 24. AWS D1.1 - Structural Welding Code - Steel; applicable edition
 25. NFPA 70 - National Electrical Code; applicable edition
 26. UL (ECMD) - Electrical Construction Materials Directory; current edition
 27. ANSI Y14.3 Multi and Sectional View Drawings
 28. IBC 2007 – International Building Code
 29. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
 30. American Public Transit Association (APTA) Heavy Duty Escalator Design Guideline
 31. AFBMA (Anti-Friction Bearing Manufacturers Association) - Std. 9 and 11.
- B. Specifications and references contained within this section are not to be construed as supplanting any code requirements governing the design, fabrication, installation or operation of the equipment.
- C. The most stringent requirement shall take precedent in case of a conflict between codes, regulations or standards incorporated into this section.
- D. Any specific provision cited herein and/or shown on the contract documents shall govern for the specified application.



- E. The Installer shall be licensed and strictly governed by local and governmental authorities of this area in order to perform this work.

1.06 SYSTEM DESCRIPTION

A. General:

1. Design escalators with provisions for thermal expansion and contraction of complete escalator assemblies due to changing ambient conditions as well as any movement of the facility. Escalators shall be of the heavy-duty type for use in transit systems, modified per these specifications to meet the requirements at the Phoenix Sky Train Station. They shall be designed to meet the operating and performance requirements of these specifications, to fit within the spaces provided, and to comply with all Code requirements.
2. No wood or wood products shall be permitted in escalator systems.
3. Escalators shall be designed per the minimum indicated transition radii and number of flat steps based on vertical rise as per the contract documents.

B. Operational Requirements:

1. Hours of operation shall be considered as twenty-four (24) hours per day, seven (7) days per week.
2. Direction of travel shall be considered as either direction, and unit shall be reversible.
3. Speed of operation shall not exceed 100 feet per minute. The no load to full load speed shall not exceed 4% of the rated speed.
4. Number of flat steps shall be per APTA guidelines.
5. Escalators shall be capable of variable speed operation as described in Paragraph 2.01.L.

C. Structural Requirements:

1. For the escalators provided, Vertical Transportation Equipment Supplier shall provide escalator truss mounting angles and intermediate truss supports with attachments, sized as required to install escalators, for lengths and vertical rise as indicated on contract documents, into wellway structural support system without structural modification.
2. Loads shall be indicated on shop drawings and shall be provided by the Vertical Transportation Equipment Supplier to the Program/Project Manager. These reaction loads shall include the dead weights of the escalators machinery, structure and truss cladding.
3. Special design loads shall be computed by the Vertical Transportation Equipment Supplier for heavy-duty, transit system type escalators as specified herein.
4. Seismic designs must be based on actual story drift data from the building's structural engineer.



5. Seismic calculations shall be based on the APTA loadings in these guidelines.
6. Escalator intermediate support points shall be provided by Vertical Transportation Equipment Supplier where required and shall be coordinated with structural bearing locations for intermediate supports. Details and calculations shall be submitted by the Vertical Transportation Equipment Supplier for coordination and record by the Engineer.
7. Escalator truss design shall have a maximum deflection of 1:1000 of the spans between supports as depicted in the contract documents using the design loads specified.
8. Foundations: Additional room for escalator controllers will not be provided for the escalators as noted on the documents.
9. Design load shall be 320 pounds per 40 inch exposed step for all truss, machinery, chains, motors and brakes.
10. Escalator Installations shall be designed to meet Seismic zone 2 criteria per ASME A17.1 requirements regardless of the local code authority requirement unless local code requirement is higher.
11. Escalator components shall be designed based on the following applied duty cycle during operation:
 - a. Three (3) Hours with 100% Rated Load
 - b. Six (6) Hours with 50% Rated Load
 - c. Fifteen (15) Hours with 25% Rated Load

D. Environmental Operations Requirements

1. General: Escalators shall be capable of operating with full specified performance capability while exposed to the following climatic and environmental conditions.
2. For Interior Escalators (those within a climatically controlled space):
 - a. Escalators shall be designed to operate in a temperature range of plus five (+5) to plus one hundred four (+104) degrees Fahrenheit, dry bulb; and all conditions of relative humidity while exposed to airborne dust and debris. However, truss heaters, combplate heaters, and oil water separators shall not be required.

E. Fire Protection

1. No wood or wood products shall be used in the escalators.
2. No products containing PVC or Halogen shall be permitted.

F. Performance Requirements:

1. Escalator rated Speed shall not exceed 100 feet per minute (FPM). Deviations in speed between no passenger load and full passenger loads shall not exceed 4% of the rated speed.
2. Sound Level: Escalators shall be designed to operate at or below a sixty-five (65) decibels sound level, measured five (5) feet above the escalator at any location, with the escalator operating normally, either free-running



or under load. For multiple escalator installation, the noise measurements shall be made with only one (1) escalator unit in operation, but with the entire installation complete and in operating condition. An ambient level not to exceed forty-nine (49) decibels shall be maintained prior to units being turned on.

3. Bearings shall be rated for an AFBMA L10 life as specified, under fluctuating bearing load. All bearings shall have basic dynamic load ratings.

- G. Labeling Requirements: Every escalator shall be clearly marked with rated load, rated speed, sleep mode speed, sleep mode detection distance, acceleration rate from sleep mode speed to normal speed, stopping distances under no load and full load, braking torque range, manufacture serial number, and the designated PSHIA identification.

1.07 JOB CONDITIONS

- A. Protection: During installations and until escalator systems are fully operative; Vertical Transportation Equipment Supplier shall make necessary provisions to protect systems from damage, deterioration, and environmental conditions.

- B. Coordination Requirements

1. Installation: The Vertical Transportation Equipment Supplier will be required to install the new escalator system. Vertical Transportation Equipment Supplier shall coordinate directly with the Contractor and the Program/Project Manager in order to properly execute this work sequence.
2. Cladding: Vertical Transportation Equipment Supplier shall provide and install truss cladding on all exposed sides of the escalators, including beneath the escalators. Refer to contract documents and other specifications for cladding material.
3. Decking: Vertical Transportation Equipment Supplier shall coordinate with the Architect and Program/Project Manager and review any and all appropriate design documents dealing with escalator decking. No exposed fastenings are to be provided and decking in between parallel escalators shall be one common piece in width. Outer decking shall consist of one-piece widths and extend to the finish walls. Drawings are to be submitted for approval.
4. Floor finish at landing plates and newels: Vertical Transportation Equipment Supplier shall coordinate with Owner and the Architect.
5. Lock and key requirements: Vertical Transportation Equipment Supplier shall coordinate with the Program/Project Manager and Owner.

- C. Site Conditions

1. Vertical Transportation Equipment Supplier shall design and fabricate escalators to fit within the wellways as designed by the Design Team.



2. Vertical Transportation Equipment Supplier shall review site conditions and measure as-built dimensions for escalator wellway(s) prior to construction of equipment and delivery of equipment to the site.

1.08 QUALITY ASSURANCE:

- A. Regulatory agencies: escalator design, materials, construction clearances, workmanship, and tests shall conform to the requirements of the codes and regulations listed in Part 1.05.
- B. Welding: Welding shall be performed in accordance with the requirements of AWS or CWB. Welders shall produce evidence of current certification by AWS or CWB.
- C. Dimensions
 1. Each escalator shall be forty (40) inch (1000mm) nominal step width as specified and designed for a maximum of 30 degrees.
 2. Escalator widths shall not exceed those indicated on contract documents.
 3. Escalator lengths shall be equal to that required by the constructed wellway.
 4. Structural dimension requirements:
 - a. It is to be understood that Vertical Transportation Equipment Supplier shall design and fabricate escalators to the requirements of the contract specifications and to meet the dimensions of the constructed wellways.
 - b. Vertical Transportation Equipment Supplier shall verify dimensions of wellways and access points prior to manufacturing trusses. An Arizona Registered Land Surveyor shall be employed by the Vertical Transportation Equipment Supplier to verify all existing wellway dimensions prior to design and fabrication of the escalators. The survey results shall be sealed by the Registered Land Surveyor and provided to Contractor and the Program/Project Manager for approval.
 5. In the event of a discrepancy, Vertical Transportation Equipment Supplier shall notify Contractor and the Program/Project Manager immediately, and shall not proceed with installation in the areas of discrepancy, until the discrepancy has been fully resolved, and Contractor has instructed Vertical Transportation Equipment Supplier to proceed. Failure of Vertical Transportation Equipment Supplier to report discrepancies shall constitute an acceptance of existing work as fit and proper for the execution and completion of Vertical Transportation Equipment Supplier's work.
- D. Requirements of Regulatory Agencies
 1. Vertical Transportation Equipment Supplier shall obtain and pay for all necessary permits and perform such tests as may be required for acceptance and approval of moving walks by jurisdictional agencies.



2. Vertical Transportation Equipment Supplier shall notify the proper inspectors to witness required testing.

E. Factory Visit

1. The Vertical Transportation Equipment Supplier shall provide for the costs of up to two (2) of Owner representatives, and up to two (2) representatives of the Program/Project Manager to visit the factory where the escalators are being manufactured, per contract, for each unit type.
2. The representative of the Program/Project Manager will dictate the length of time required to perform the factory test and will have the right to control the testing being conducted in the factory to his satisfaction.
3. The escalator shall be tested and inspected with its own designated controller. The Program/Project Manager and Owner representatives shall observe the testing of the controller operation and the testing of the safety devices in the escalator. The balustrade and handrails shall be completely assembled for these tests. The escalator shall be fully assembled and capable of operating with all steps installed, at either a 30 degree angle or horizontal in the factory, whichever is feasible.
4. The Vertical Transportation Equipment Supplier shall not ship the escalators without the approval of the Program/Project Manager and Owner after the conclusion of the factory visit.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:

1. Accept equipment, materials, and other Products on site in factory containers, bundles, and shipping skids.

B. Delivery and Acceptance at Site:

1. Deliver material in original packages, containers, skid loads, or bundles bearing brand names and identification of source of manufacture or supply.
2. Inspect deliveries for damage.

C. Storage and Protection:

1. Store materials inside under cover and in a dry location.
2. Protect from weather, direct sunlight, surface damage, corrosion, and construction traffic and activity.
3. Vertical Transportation Equipment Supplier shall make necessary provisions to protect systems from damage, deterioration, and environmental conditions during installations and until escalator systems are fully operative.

D. Handling:

1. Handle material to prevent damage to edges, ends, surfaces, and finishes.



1.10 SUBMITTALS

- A. General: Submittal shall contain sufficient detail to show full compliance with Contract Documents.
- B. Product Data:
 - 1. Submit manufacturer's product data for each product and material
 - 2. Indicate manufacturer, trade names, and model numbers, components, arrangement, optional and accessories being provided.
 - 3. Include applicable literature, catalog material or technical brochures.
 - 4. Include material and equipment specifications, sizes, types, dimensions, weights, rated capacities, and performance curves.
 - 5. Include utility requirements for wiring, piping, and service connection data, motor sizes complete with electrical characteristics.
- C. Shop Drawings:
 - 1. Seven (7) copies of the layout and shop drawings shall be provided by the contractor for review within thirty (30) days of notice to proceed.
 - 2. Surveys sealed by an Arizona Registered Land Surveyor demonstrating that the Vertical Transportation Equipment Supplier has confirmed the dimensional requirements of the new escalators to be installed, including but not limited to, vertical rise, locations from columns, wellway lengths and widths, pit depths, and location of intermediate supports shall be provided.
 - 3. All drawings, views and details shall be developed and presented in accordance with ANSI Y14.3 Multi and Sectional View Drawings.
 - 4. Drawings shall clearly reflect dimensional data for escalator wellways including cross references to building column lines and finish elevations depicted in the Contract Documents.
 - 5. Escalator layout shall be shown in three orthogonal views and shall include key dimensions, support details, power connection locations and power connection terminal points. General layout shall include a cross section taken through the escalator between the escalator work points. Step nosing radii at the upper and lower transitions shall be clearly dimensioned.
 - 6. Bolt torque settings, including thread lubricant specifications, for all field critical connections and adjustments shall be clearly indicated on the layout drawings. Bolt torques shown shall include, but not be limited to, the following:
 - a. End support leveling set screws/jack bolts
 - b. Intermediate support leveling set screws/jack bolts, as required
 - c. Truss split connection systems, as required for multiple section trusses
 - 7. Submit detail drawings, including sizes, tolerances, materials and part numbers for the following systems and/or components:
 - a. Escalator truss structure



- b. Step and step chain guidance track system and supports
- c. Escalator drive machine assembly including drive chains and/or gear transmission details
- d. Escalator service brake assembly, including brake torque data and curves
- e. Emergency and main shaft brake systems including brake torque data and curves
- f. Step chain assembly including pitch, link plates, pins, bushings and rollers
- g. Step assembly including axle(s), step tread, step riser, frames and rollers
- h. Handrail system including drive, cross section of profile, guides and tensioning devices
- i. Escalator supports including end supports, intermediate supports, fixed supports and slip supports as required.
- j. Balustrade system including decking, interior panels, skirt panels and related connections.
- k. Operating stations including emergency stop button, direction selection switches and labeling.
- l. Floorplates and floor plate frames, including adjustment details.
- m. Ceiling intersection and apex guards, where applicable.
- n. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in machinery spaces, truss envelope, and pits.
- o. Safety Devices including, but not limited to, the following:
 - 1) Comb impact devices
 - 2) Handrail entry guards
 - 3) Broken drive chain switches, as applicable
 - 4) Broken step chain switches
 - 5) Skirt obstruction devices
 - 6) Missing step devices
 - 7) Missing and Deteriorated roller devices.
 - 8) Skirt Brushes
- 8. Shop drawings shall include complete schematic and connection diagrams for each controller and all electrical devices including a legend for components.
- 9. Controller information should include complete I/O list.
- 10. A narrative of the Variable Speed Operation shall be submitted for review. The narrative shall include detailed information including acceleration rate, sleep mode speed and detection distance. It shall include the Product Data for the detection system to be utilized. Mechanical shop drawings indicating the arrangement of the detection system shall also be provided.
- 11. All drawings shall reflect conditions as coordinated with the design by the design team members and reflect the coordinated and field measured wellway lengths, vertical rises, controller room locations/sizes, support



conditions, finish conditions and electrical requirements, and be provided electronically in an electronic format acceptable to PSHIA.

D. Installation and Rigging Plans:

1. Seven (7) copies of the installation and rigging plans shall be provided by the Contractor for review no later than six (6) weeks prior to start of installation.
2. Installation and rigging plans shall include both a narrative description of the installation sequence and sketches illustrating the path of egress through the facility. Sizes of openings in the facility shall be clearly indicated.
3. All loads imparted on the structure shall be shown.
4. Details shall be provided clearly depicting proposed connections of rigging equipment and means proposed to protect adjacent finishes.

E. Samples:

1. Submit [6] samples for the following:
 - a. Handrail – 6 lineal inch length of proposed handrail
 - b. Decking – 6 inch square sample of proposed decking material
 - c. Skirting – 6 inch square sample of proposed skirting material
 - d. Floor Plate – 6 inch square sample of proposed floor plate material
 - e. LED light fixtures – one (1) full operating length or unit.
2. Samples shall be clearly labeled to reflect:
 - a. Project Name
 - b. Contract Number
 - c. Description of Sample

F. Maintenance programs: within sixty (60) days after notice to proceed, and prior to installation, Vertical Transportation Equipment Supplier shall submit detailed interim and revenue service maintenance programs, showing functions to be performed and their scheduled frequency.

G. Operating and Maintenance Manuals: Prior to installation, Vertical Transportation Equipment Supplier shall submit seven (7) complete sets of operation and maintenance manuals for approval. After PSHIA approval and prior to the beginning of acceptance testing, twelve (12) sets of the approved manuals shall be provided by the Vertical Transportation Equipment Supplier. The manuals shall include the following:

1. Complete table of contents.
2. Complete instructions regarding operation and maintenance of equipment, including disassembly and assembly of drive system, handrail drive assembly, and track system. Included will be complete illustrated, exploded views of all assemblies, and a complete, illustrated, exploded view for identifying all system parts.



3. Complete nomenclature of replaceable parts, part numbers, current cost, and warehouse location. If product source is another vendor, Vertical Transportation Equipment Supplier shall include name and address of other vendor.
4. Sample copies of a proposed preventive maintenance chart.
5. Descriptions of safety devices.
6. Safety rules, tests, and procedures, including testing of all systems and subsystems.
7. Procedures for adjusting brake, handrail tension, handrail chain drive tension, step chain tension, track system, and mechanical components, including pictorials.
8. Instructions for removing floor plate, replacing comb segments, and removing and installing steps, and interior panels.
9. Troubleshooting techniques.
10. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.
11. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each escalator and group of escalators. Complete I/O list shall also be provided.
12. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in remote controller room, truss envelope, and pits.
13. Complete detailed drawings and wiring diagram of escalator fault-finding device and connection to annunciator panel.
14. As built drawings for final escalator installation, controller and truss wiring. Also provide As-built drawings in electronic format in AutoCad 2016 or other electronic format required by PSHIA.
15. In addition to the manual, an escalator installer's laptop used to interface with the controller shall be provided to PSHIA.
16. The manufacturer's complete Maintenance Control Program shall be provided in both hard copy and electronic format to PSHIA.

H. Certification

1. The Vertical Transportation Equipment Supplier shall be required to provide certification, in writing and signed by an officer of the organization, that PSHIA shall be provided with copies of any and all information, correspondence, bulletins, newsletters, manuals, techniques, procedures, drawings, sketches and any other documents related to maintenance, safety, operations, design changes, modifications, retrofits, etc., which relate to any part, component, equipment, system, subsystem, or material and services applicable to the escalator provided.
2. All of the above referenced shall be provided as it pertains to the original installation and for a period of ten (10) years after final acceptance of the last escalator provided under any contract.



3. The referenced material shall be provided within thirty (30) days of publication or internal distribution by the Vertical Transportation Equipment Supplier. The material, even if labeled PROPRIETARY, shall be delivered to the Engineer without prejudice or delay and at no additional cost.
 4. The entire manual shall be also provided in an electronic format on CD-ROM that is acceptable to PSHIA.
- I. Quality Assurance/Control Submittals
1. Design Data reflecting compliance with referenced Codes and Standards along with the custom requirements of this specification shall be submitted.
 2. Engineering Calculations
 - a. Motor Sizing Calculations
 - b. Truss Deflection Calculations
 - c. Step Chain Tensile Stress Calculations, including factor of safety
 - d. Step Chain Pin Pressure Calculations
 - e. Truss Support Point Reactions
 - f. Story drift and seismic reaction calculations.
 3. Test Reports
 - a. Step Fatigue Test certificates
 4. Certificates
 - a. Welding certifications to AWS D1.1 or CWB.
 - b. Step Chain Certificate of Breaking Strength
 5. Manufacturer's Instructions and Field Reports.
- J. MSDS and product data sheets: Shall be submitted with an index listing each product, along with the application method of the product, approximate quantity per escalator and the component the product is applied or associated with. The Installer shall allow six (6) weeks for review of MSDS.
- K. Provide copies of all Code Authority permit submittals to PSHIA and documentation showing when the permits are closed at the completion of the project.

1.11 ACCEPTANCE AND WARRANTY

- A. The Vertical Transportation Equipment Supplier shall warrant in writing that all equipment manufactured and installed under this specification, for a period of twelve (12) months from the date of Final Acceptance by PSHIA, be free of defects in design, materials, and workmanship, under normal use and service. Defective work shall be repaired or replaced at no additional cost to PSHIA. Warranty period for all escalators shall start when the deficiencies identified for the escalator are addressed and signed off by the Program/Project Manager and PSHIA.



- B. The warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to, noisy, rough, or substandard operation; loose, damaged, and missing parts; and fluid leaks.

1.12 GUARANTEES

- A. Notwithstanding the Specifications forming a part of this Contract, any inspection or approval of the Work by PSHIA, or the existence of any patent or trade name, the Vertical Transportation Equipment Supplier nevertheless unconditionally guarantees that the equipment furnished and installed hereunder shall be of the best quality, shall be fully fit for the purpose for which it is intended, and shall be of the heavy duty transit type in compliance with APTA guidelines and augmented per these contract documents.

1.13 PSHIA INSTRUCTION / DEMONSTRATION AND COORDINATION

- A. The Vertical Transportation Equipment Supplier shall provide eight (8) hours of off-site demonstration and instructions to a total of six (6) PSHIA and/or existing service personnel upon completion of the escalator installation. Instructions are to include safety procedures, proper operation of all equipment, and routine maintenance procedures. All instructions and demonstrations are to be video recorded and remain the property of PSHIA. All costs associated with this off-site training shall be the responsibility of the Vertical Transportation Equipment Supplier.
 - 1. Provide manuals for all material covered in the training program. This training will take place at the discretion of the Owner at any time prior to the end of the warranty period.
- B. Check operation of all the escalators with PSHIA personnel or designated representative present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Vertical Transportation Equipment Supplier shall furnish and install heavy-duty escalators that shall comply with the requirements of these contract documents.
- B. All escalators supplied under this contract shall be the product of a single manufacturer.
- C. Acceptable Manufacturers – Manufacturers must manufacture within the continental United States or provide written guarantee for the life of the



equipment that replacement parts will be provided to PSHIA within 48 hours of request.

1. KONE Elevator Company
2. Otis Elevator Company
3. Schindler Elevator Company
4. ThyssenKrupp Elevator Company
5. Approved Equal

D. Escalators shall comply with the following Basis of Design requirements:

1. Vertical Rise: Shown on contract documents
2. Inclination: 30 degrees
3. Nominal Step Width: 40 inches (1000mm)
4. Speed: not to exceed 100 FPM
5. Number of Flat Steps:
 - a. minimum Three (3) Flat Steps (Top and Bottom)
6. Minimum Transition Radii:
 - a. Upper Landing: minimum 2.6m (8'-6")
 - b. Lower Landing: minimum 2.0m (6'-6 3/4")
7. Head Dimensions: As required to fit structures.
8. Static Brake Load: The load per step the total number of exposed steps on the incline:
 - a. 1000mm step: 306 kg (674lbs)
9. Dynamic Brake Load: The load per step running in down direction on exposed steps on the incline:
 - a. 1000mm step: 145 kg (320lbs)
10. Motor Duty Load: Continuous operations with a minimum step load per step (on incline only) as follows:
 - a. 1000mm step: 145 kg (320lbs)
11. Step Chain Load: is to be based on the step loads as follows:
 - a. 1000mm step: 145 kg (320lbs)

E. Controls and Safety Devices

1. Operating Controls:

- a. Escalators shall have key operated switches, accessible at both upper and lower landings, located on the exterior deck above the newel base. Operating controls for glass balustrade escalators may be mounted on posts in lieu of lower exterior decking subject to full conformance with governing Codes and acceptance of submitted designs from the supplier by the Program/Project Manager. Combination Emergency Stop Button / Start Switch shall be provided as manufactured by PTL or approved equal.
- b. Each keyed switch shall be clearly and permanently labeled, including starting and direction selection.
- c. Interlocks shall be provided to bring the escalator to a smooth stop, in either direction of travel, before a change of direction may be made.



Schneider Alternative PLC
AB is approved, see link



2. Safety Devices:

- a. Safety devices required by the latest edition of ANSI/ASME A17.1 shall be provided on each escalator.
- b. Safety devices shall be mounted in locations accessible for maintenance within escalators, and these devices shall be designed for ease of adjustment or reset. Devices shall be located so that operation is not affected by direct moisture and debris.
- c. If escalators are equipped with braking system dependent upon activation of springs, then springs shall be of guidance compression type. The use of weights or self-excitation of the brake release shall not be allowed.
- d. Disconnect switches capable of being locked in the "off" position shall be provided in both escalator pits, and at the drive of each escalator to prevent the starting of escalator from any other location.
- e. Combplate switches that detect the vertical tripping force shall be independent of the switches that detect the horizontal tripping force.
- f. A pit stop switch shall be provided in the top and bottom escalator pits which will, when used, stop the escalator or prevent starting.
- g. Deteriorated and Missing Roller Detector: Provide a device for detecting deteriorated and/or missing step and axle rollers on the left and right sides while the escalator is running with or without passengers or load. The roller detector shall be integrated into the safety circuit. The device shall be manually reset.
- h. In addition, a fault-finding device (diagnostic equipment) shall be provided, capable of producing indications of the following data:
 - 1) Date, time, and cause of all escalator stoppages and failures.
 - 2) A monitoring of drive motor temperature.
 - 3) Have a digital readout visible at the key start switch area.

F. Operating Controls / Emergency Stop Button:

1. Provide vandal resistant device(s) manufactured by PTL or approved equal.
2. Operating switches shall comply with Paragraph 2.01.E.1.
3. One (1) vandal resistant emergency stop button shall be located at each landing, accessible on the exterior deck cover for solid balustrade escalators and mounted in the upper newel quadrant or in a pedestal for glass balustrade escalators.

G. Balustrades and Skirt Panels

1. Glass Balustrades for Low Deck Escalators shall comply with the following:
 - a. Constructed of 3/8" (10 mm) minimum clear tempered safety glass.
2. Skirt panels with rounded joints shall be of type 316 Stainless Steel, solid construction, and shall be in conformance with A-17.1 Code. There shall be no laminations or square joints allowed.



3. Skirt Brushes along both sides of the skirt panel. Skirt brush must be installed at least one (1) inch above the nose of the step line. Brush material is to be flame retardant. Skirt brushes shall incorporate two (2) rows of bristles and intermediate sections shall be capable of being removed independently of the rest of the brush installation for access to motors or other sections of the truss interior.
4. Panels on exterior escalators shall have edges sealed against moisture.
5. Panels shall be constructed, when practical, in equal lengths for interchangeability.
6. Panels shall be attached to permit easy removal for inspection, lubrication, and adjustment of safety devices.
7. Panels shall be sized so that not more than two (2) persons shall be required to remove a panel, and without the aid of special handling equipment.
8. Panel fastener requirements: Panels shall be fastened to their respective supports or mating portions with tamper-proof, flathead machine screws.
9. When framework to which panels are fastened is less than one-quarter (1/4) of an inch thick, steel backup plates with a minimum one-quarter (1/4) of an inch thickness shall be added which have tapped holes or clearance holes where necessary.

H. Decking and Cladding:

1. Decking Shall be type 316 stainless steel, identical to balustrade, with minimum of 2mm thickness.
2. Decking between escalators shall be designed to support a live load of one hundred and seventy-five (175) pounds per square foot, without surface deflection and shall be of one piece in width and shall not require the installation of deck barricades along the incline in order to meet code requirements.
3. Paneling, decking, and other enclosures shall be supported on steel framework.
4. All decking is to be extended to finish walls and in one-piece widths.
5. All decking and cladding is to be provided with no exposed fasteners. Submit drawings for approval by the Program/Project Manager.
6. Truss cladding shall be provided by the Vertical Transportation Equipment Supplier on all sides and underside of escalator truss. Cladding shall be type 316 stainless steel unless otherwise specified elsewhere in these contract documents. Truss cladding finish shall be coordinated with: PSHIA/Architect.
7. All deck barricades shall be the responsibility of the Vertical Transportation Equipment Supplier. The design of the deck barricades shall be per PSHIA Standard as installed at the other PHX Sky Train Stations.
8. At the upper and lower ends of the escalators with common inner decks, additional PSHIA Standard signage shall be installed on stainless steel



pedestals, matching that used for the combination start/stop stations.
Pedestals shall be fabricated from bent stainless steel pipe/tube.

I. Escalator Lighting Fixtures:

1. Step demarcation lights (located below steps at both landings) shall be provided in accordance with code requirements. Each landing shall have a minimum of three (3) LED type lighting elements.
2. Combplate lighting fixtures shall be provided by LED type fixtures
3. Escalator shall be furnished and installed with maintenance lighting in each pit with quick start type PL compact fluorescent lamps as required for complete illumination of working spaces and specified areas within the interior of the escalator and its immediate surroundings. Upper and lower pits shall have internal lighting of 15-foot candles as a minimum. A main light switch shall be located at the entry to each wellway and/or pit. Vertical Transportation Equipment Supplier shall coordinate location with the Program/Project Manager and PSHIA.
4. Glass Balustrade / Low Deck Escalators shall be provided with under handrail lighting that shall be of the LED type. Lighting shall be of a color temperature determined by the Architect to coincide with lighting in the facility.

J. Electrical Equipment

1. Motors

- a. The driving motors shall be A.C. induction motors with solid-state starters. Voltage-480 V.A.C., 3-phase, Frequency - 60 Hertz.
- b. The motors shall be totally enclosed with external cooling fins.
- c. The motor protection class shall be equivalent to IP 55 Insulation group: F or higher.
- d. Driving motors and motor switchgear shall provide a smooth start.
- e. The motor shall be designed for operation(s) under a load as follows:
 - 1) 1000mm wide step: 145kg per step on the incline

K. Escalator Control System:

1. The escalator control equipment shall contain diagnostic capabilities as required for the ease of complete maintenance. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the service person and the controls. All such systems shall be free from decaying circuits that must be periodically reprogrammed by the manufacturer.
2. Switchgear shall be mounted in NEMA 2 cabinets with labeled terminal strips.
3. Controller shall be based on SCADA compliant Programmable Automation Controller (PAC) system to control and monitor the status of the escalator.



- The PAC shall be designed to communicate in TCP/IP format over Ethernet or approved equal.
4. The PAC racks shall provide space for two (2) future single slot modules.
 5. The PAC shall store the last 99 faults, accessible via laptop connection, panel view or remote communications.
 6. Provide a copy of all working programs on approved computer medium as well as a printed program listing.
 7. The PAC shall have one dedicated serial port, which supports RS-232-C signals. It shall be accessible in ladder logic and provide support for Point to Point and Slave SCADA communication protocol systems. Alternatively, it must be usable for programming purposes or for access to remote programmers via modems.
 8. The main control switchgear of an escalator shall contain at least the following devices:
 - a. Lockable main switch thermal and magnetic motor protection starter for up and down travel, hour counter, auxiliary contactors, phase failure device, phase sequence monitor, and ground fault monitor.
 - b. The controller cabinet shall contain a permanently mounted full color view panel capable of providing fault and operating data.
 - c. The indication shall be locked automatically. Reset shall be done by a separate switch installed in the controller. The emergency stop shall not be locked.
 - d. All terminals shall have identification markings and all cables shall be provided with cable markers.
 - e. The controller shall be equipped a solid-state device, capable of starting motors smoothly and gradually, reducing inrush current and mechanical shock upon start up. Adjustable settings for accelerating time and starting torque shall be provided. The starter shall also contain auxiliary contacts and a thermal overload relay for motor protection.
 - f. Maintenance Receptacles: Electric power receptacles shall be furnished and installed in the upper and lower pits. Each receptacle shall be of the GFCI duplex type, waterproof, grounded, and rated for one hundred and twenty (120) volts at twenty (20) amperes. The receptacles in the pits shall be surface mounted on the walls, not less than thirty (30) inches from the floor.
 - g. Relays shall be provided with visual indication that they are energized.
 - h. Adjustable settings for accelerating time and starting torque shall be provided. The starter shall also contain auxiliary contacts and a thermal overload relay for motor protection.
 - i. Controllers in escalator pits shall have a flexible liquid tight connection of suitable length to permit removal for maintenance purposes.



- j. Controller shall be capable of operating the escalator in Variable Speed Operation as per ASME A17.1-2010 requirement 6.1.4.1.1
 - k. The controller shall utilize a graphic HMI with Ethernet for interface.
 - l. Provide dielectric floor mats in front of each controller.
- L. Remote Monitoring System: A Lift Net remote monitoring system shall be provided by the Installer and all escalators shall be connected to this system. The Lift Net remote monitoring system shall be capable of reporting real-time status of the escalators, i.e. running up/down normal operation or sleep mode operation, as well as the status of individual safety switches. It shall be capable of indicating and reporting the exact fault that would appear on the fault indicating devices on the escalators. In addition, the escalators shall be connected to the Honeywell Device Monitoring System (DMS) and the installer is responsible for providing all provisions necessary for connecting the escalator to the DMS as well as the Lift Net system. Connection to the DMS will be through contactors and connection to Lift Net may either be through Wi-Fi or Ethernet. This is to be coordinated with PSHIA IT Department.
- M. Maintenance Drive Unit: Means shall be provided for reduced speed maintenance operation that shall be controlled by a manual handset. When operated, the escalator shall run in the direction selected, at a speed of not more than 25% of rated speed. This speed shall be maintained when steps are removed for servicing. Escalator operation shall be continuous so long as an up or down button on the handset is being pressed.
- N. Fully Regenerative VVVF Drive Unit
 - 1. A fully regenerative VVVF drive unit shall be capable of controlling the speed of the escalator under no load, full load and sleep mode operation without adjustments for varying loading conditions. Drive shall be manufactured by or commonly used by the Installer for this type of escalator.
- O. Variable Speed Operation: Sleep mode operation shall comply with the following:
 - 1. The acceleration and deceleration rates of the escalators shall not exceed 1.0 ft/sec² (0.3 m/s²).
 - 2. The rated speed is not exceeded.
 - 3. The minimum speed of escalators shall not be less than 10 ft/min (0.05 m/s).
 - 4. The speed of the escalator shall not automatically vary during inspection operation mode.
 - 5. Passenger detection means (as provided in Paragraph P below), shall be provided at both landings of the escalator such that:



- a. Detection of any approaching passenger shall cause the escalator to accelerate to, or maintain the, full escalator speed in compliance with paragraphs 1 thru 4 above.
 - b. Detection of any approaching passenger shall occur sufficiently in advance of boarding to cause the escalator to attain full operating speed before a passenger walking at normal speed (270 fpm (1.35 m/s)) reaches the comb plate.
 - c. Passenger detection means shall remain active at the egress landing to detect any passenger approaching against the direction of escalator travel and shall cause the escalator to accelerate to full rated speed and sound an alarm bell at the approaching landing before the passenger reaches the combplate.
 6. Automatic deceleration shall not occur before a period of time has elapsed since the last passenger detection that is greater than 3 times the amount of time necessary to transfer a passenger between landings.
- P. Passenger Detection Means: Escalators shall be provided with four sets of Angled Infrared Photoelectric Proximity Detectors installed per Paragraph O above. They shall be installed in the lower newel cladding at both ends of the escalator in the vicinity of the handrail entry points. They shall be Radar detectors / transmitters or LT transmitters and LR receivers, Series 110 with stainless steel housings as manufactured by Telco Sensors or approved equal. 2-channel multiplexed photoelectric amplifiers, model PAB20 as manufactured by Telco Sensors or approved equal shall be provided as required for each escalator and associated number of transmitter/receiver sets.
1. Means shall be provided to detect failure of the passenger detection means and shall cause the escalator to operate at full rated speed only.
- Q. Truss Wiring and Conduit:
1. Galvanized rigid pipe and/or Liquid tight flexible metal conduit shall be used in the truss.
 2. In class 2 circuits, SO Cord may be used in lengths not to exceed three feet.
 3. Liquid tight flexible metal conduit must be CSA/UL approved and have an overall halogen free jacket.

2.02 MATERIALS

- A. Stainless Steel
1. Shapes and Bars: ASTM A-276, type 316, A-554 for tubes.
 2. Plate, Sheet, and Strip
 - a. Over one-eighth (1/8) of an inch: ASTM A264 with ASTM 240. Type 316 on A36 base.
 - b. Under one-eighth (1/8) of an inch: ASTM 167, Type 316.



B. Fasteners

1. Vertical Transportation Equipment Supplier shall provide nuts, bolts, washers, screws, and other fastenings necessary for proper erection and assembly of work.
2. Fasteners shall be compatible with materials being fastened. Fasteners shall be furnished with self-locking nuts or retaining rings (spring washers, toothed disks).
3. Fasteners shall be equal to or of greater corrosion resistance than the most corrosion resistant metals being fastened.

2.03 FINISHES

A. Stainless Steel: Decking - Brushed # 4 finish ASTM A-480. Truss Cladding shall be coordinated with the Architect.

B. Aluminum Castings and Extrusions: Commercial mill finish.

C. Galvanizing

1. Sheet Steel: ASTM A446, or A526, as applicable. Coating designation G185.
2. Other galvanizing: ASTM A123, ASTM A153, ASTM 385, or ASTM 386, as applicable.

D. Galvanizing Touch-up: Zinc dust coating, MIL-P-21035 or MIL-P-26915.

E. Paint and Corrosion Protection: Each escalator shall have the following minimum corrosion protection:

1. After welding, the truss shall be hot-dipped galvanized with a coating in accordance with ASTM A90. A 100% zinc thermal spray coating to ASNI/AWS C.18-93 is an acceptable alternative.
2. Cast metal parts such as gear housings, chain sprockets and return station half circles, shall be painted with a rust-inhibitive primer, zinc chromate coat after preparation by sandblasting.
3. Steel parts which are not specified to be galvanized shall be painted as follows:
 - a. Primer coat - two (2) mil (dry film thickness), minimum thickness.
 - b. Second finish coat - two (2) mil (dry film thickness), minimum thickness.
4. Bright or uncoated axles, shafts, etc. shall be protected by zinc chromate, or chrome plating.
5. Oil collector chutes and collection trays shall be fabricated of galvanized steel.
6. All shims shall be manufactured from stainless steel.

2.04 MECHANICAL EQUIPMENT

A. Tracks



1. Design and fabrication of tracks shall retain steps and running gear safely under load requirements and at the highest design speeds specified.
2. Vertical Transportation Equipment Supplier shall assemble and secure sections of track together for easy removal and replacement of defective sections. The system shall be adjustable, and welding of the tracks is not acceptable.
3. Design of the mechanical components shall provide for easy installation and removal without the dismantling of parts of the structure.
4. Track joints shall be smooth and free of burs and sharp edges.
5. Tracks shall be properly supported on trusses to provide correct alignment and smooth transition to return stations. The rolling surface of the passenger side track shall be a minimum thickness of 3mm. Return side track shall be a minimum thickness of 2mm.
6. The track radius shall be determined in conformance with these specifications and the following constraints:
7. The requirement for requisite number of flat steps shall be met.
8. Track loading and wheel size shall be such that interaction force between each wheel and track shall permit escalator to meet requirements specified.
9. The guiding system for the step chains and step wheels shall be of zinc plated or galvanized steel profiles with smooth and even running surfaces, and with the joints cut diagonally to the running direction. The guide profiles shall not be welded together at the joints.
10. A second, continuous guiding profile shall be provided above the step chain rollers so that the step chains are positively guided in the area of the escalator open to passengers
11. Transition radii shall be based on minimum 2.6m for the upper landing and 2.0m for the lower landing for steps on the passenger side of the escalator.
12. Systems including step chain rollers outside the step chain links and relying on stress relieving curves through the transitions shall include stress relieving curves on both the passenger and return sides of the track system at the transition curves.

B. Steps

1. The entire step assembly shall be treated with not less than one (1) coat of zinc chromate primer or iron phosphate and one (1) coat of powder coated enamel for corrosion-resistance.
2. Steps and their various attachments shall permit removal of steps without disturbing balustrades.
3. Sound deadening shall be applied to the underside of the steps.
4. Step rollers shall have polyurethane tires on hubs, sealed roller bearings, and a diameter of no less than four (4) inches. Step rollers shall not require any additional lubrication and must be rated for severe, heavy-duty service. Step roller bearings shall have an L10 rating of 100,000 hours.



5. Steps shall be constructed so as to be driven by step linkages to step rollers.
6. Vertical Transportation Equipment Supplier shall provide washers and nuts as follows:
 - a. Tap bolts: Lock washers
 - b. Through bolts: Lock nuts or Program/Project Manager approved equal.
7. Rated Loads:
 - a. In addition to the minimum requirements given in the Codes Vertical Transportation Equipment Supplier shall design the Steps for a minimum load of three hundred and twenty (320) lbs. (145 Kg) per forty (40) inch step with a safety factor of eight (8).
 - b. The steps shall carry the load under maximum concentric and eccentric loading conditions without distortion.

C. Step Chain

1. Vertical Transportation Equipment Supplier shall provide endless, roller-type step chains; one (1) on each side of step.
2. Step chains shall be of heat-treated steel construction, supported at intervals by linkage wheels.
3. A means to prevent steps from coming into physical contact with each other and to prevent chains from sagging or buckling shall be provided.
4. A means to maintain constant distance between step axles shall be provided.
5. An automatic tensioning device to maintain tension under load and to compensate for wear shall be provided. The device shall be located within the truss at the lower end.
6. A means for individual fine adjustment of tension for each linkage shall be provided.
7. Step chains shall be constructed to permit removal of segments as may be required for replacement purposes at a minimum of every 6-axle section. Each escalator shall have at least two one axle sections.
8. Support wheels spaced to distribute load and to guide linkage throughout run shall be provided. Rollers shall be constructed of polyurethane material, with diameter sufficient to provide reliability, maintainability, smoothness of motion, and to operate within noise level requirements specified. The chain rollers shall have polyurethane tires, sealed bearings, a diameter of not less than four (4) inches, must require no additional lubrication, and be mounted outside the chain link wheels, hubs and bearings shall have an L10 rating of 100,000 hours.
9. Wheels shall be affixed to permit rapid replacement.
10. Each pair of step chains shall be a matched set within manufacturing tolerances. Only precision, roller-fishplate chains of high-grade, heat-treated steel shall be used as step chains. The pins, axles, bushing, and rollers shall be hardened and ground.



11. Step chain and chain pins shall have a minimum diameter of at least five-eighths (5/8) of an inch. In addition, the diameter will be of a size so that surface pressure at engaging points will not exceed 30N/mm² (3,450 psi). This is to be based on the step loads as follows:
 - a. 1000mm wide step: 145Kg (320 lbs.) per step on the incline.
12. The safety factor shall be at least 6.
13. A test certificate for the chain-breaking load shall be provided.
14. A shielding device shall be provided to protect chain, track guides, and rollers against water, dirt, and debris.

D. Combplate Assemblies

1. Complete assemblies of wear resisting, non-corrosive metal material with exposed anti-slip surfaces shall be fabricated.
2. Combplate sections meeting the following requirements shall be provided:
 - a. Shall be removable to permit ease of replacement.
 - b. Shall be yellow in color for safety/demarcation.
 - c. Provisions for lateral and vertical fine adjustments shall be provided so that cleats of step treads pass between combteeth with minimum clearances.

E. Floor Plates

1. Shall have type 316 stainless steel frames at floor openings, designed to be supported on truss heads.
2. Shall be designed to cover entire area of upper and lower landings.
3. Shall be reinforced, as necessary, to be rigid and able to withstand a live load of two hundred and fifty (250) pounds per square foot with minimal deflection.
4. Shall be extruded aluminum in a ribbed pattern transverse to the escalator axis. Ribs shall be designed to provide maximum traction, and will be finished in the same manner as the combplates.
5. Shall be lightweight and removable for ease of access to machinery and maintenance areas below. Must be fabricated in sections of a size and weight capable of being handled easily by one (1) person. Fastening system is to be an integral part of the floor plate design.

F. Drive Machinery

1. Motor and drive mechanism shall be mounted within the truss envelope at the upper end. Shafts shall be designed for ease of assembly or disassembly using square keyways of proper sizing.
2. Gear Box Requirements:
 - a. Gear bearings shall be rated with an AFBMA L10 life of 200,000 hours and housed in an oil-tight, dust-proof case provided with a sight glass or dipstick method of determining oil level in the case. The case shall provide a convenient method of the draining oil.
 - b. Use synthetic lubricants, subject to PSHIA approval.



- c. Rotating parts shall be provided with a means for lubrication and retention of lubricants.
- d. Sealed bearings shall be used.
- e. Exposed, moving, drive elements shall be protected by metal housings, which shall provide access for lubrication of components.
- f. Provide a low oil sensor to prohibit starting of the escalator on automatic operation with low oil in the gearcase.
- 3. V-belt and tooth belt drives shall not be considered acceptable
- 4. Head-shaft bearings shall be rated for AFBMA L10, 200,000 hours.

G. Drip Pans

- 1. Galvanized, 3 mm steel, watertight drip pans for the entire length and width of trusses shall be provided. Drip pans shall be of sufficient strength to support a concentrated weight of five hundred (500) pounds at any place in the drip pan. They shall also be sloped for proper drainage and collection of lubricants as well as any moisture or water which may enter the escalator. They shall be constructed to prevent oil from leaking below the truss.
- 2. Oil water separators shall be provided on outdoor escalators only.
- 3. Drip pans of sufficient size to collect and maintain, within truss areas, oil and grease drippings from step linkage and all forms of loose debris that may be deposited in drip pans from steps at turn-around points at upper and lower portions of truss shall be provided. This system shall be separate from the water drain in order to prevent the discharge of lubricants.
- 4. Access to drip pans at lower landings of escalators for the purpose of cleaning drain catch basins shall be provided.

H. Handrails

1. General

- a. Handrails shall receive their motion from main escalator drive through direct gearings and drive shaft or drive chains, so that handrail and steps operate at the same speed in each direction of travel.
- b. A means to take up handrail slack using a tensioning device, where required, shall be located within escalators. In addition, a method of releasing the device for repair or removal of handrails shall be provided.
- c. Newels meeting the following requirements shall be provided:
 - 1) Newels shall be designed and constructed so that handrail shall return into newel end at a point inconspicuous and difficult for passengers to reach.
- 2. Handrails, handrail drive system, and guides shall be so designed and installed that handrail cannot be thrown off or disengaged while running, and special design attention shall be given to area where handrail passes from drive system to guides.



3. Handrail rollers shall have sealed bearings rated at AFBMA L10, 100,000 hours.
4. Friction drive sheaves and idlers shall be designed and positioned so that lubricant cannot reach surface of handrail. Marking and spotting of handrail by drive equipment shall not be permitted. Provide sealed bearings rated at AFBMA L10, 100,000 hours.
5. Handrail shall be a composite of either vulcanized rubber or approved equal with a synthetic fabric slider and shall be constructed with a steel cable tension member providing a minimum strength of 25kN over the splice area.
6. Handrail color shall be black.
7. Handrail guides shall be continuous on exposed portion of handrails, constructed of 316 stainless steel which shall not subject to corrosion nor pitting, and shall have a polished or specially coated, permanent finish to minimize frictional wear to under surface of handrail. On the unexposed portion, guiding shall be by adjustable rollers having sealed bearings, and set in a way so as not to cause wear on the handrail.
8. Handrail gearbox, if provided, shall have bearings rated at AFBMA L10, 200,000 hours.

I. Braking Requirements

1. Motor Brake

- a. Brake shall be capable of stopping and holding a descending escalator with a load on the exposed steps in the incline area of:
 - 1) 1000mm wide step 145kg (320 lbs.) Per step
- b. The brake coil shall be insulated to class F.
- c. A monitor shall be provided, and if brake lining becomes insufficient for safe usage, restart of escalator shall be prevented.

2. Step Band Lock

- a. Shall be manually applied and mechanically engaged to prevent movement of linkages, while escalator is disconnected from its power supply.
- b. Electrical interlock that shall prevent escalator drive motors from starting while step band lock is engaged shall be provided.

J. Trusses

1. General

- a. Trusses shall be sufficient total length to provide minimum number of flat steps required per code along with the transition radii indicated in the contract documents. The truss shall span the distance between the support points as indicated.
- b. Trusses shall be sufficient width to accommodate the width of the finished escalator.
- c. Trusses shall be designed to rest on the top and bottom support beams, and intermediate supports provided for each location.



- Vertical Transportation Equipment Supplier shall use 316 stainless steel shims for installation with a maximum shim height of 2 inches.
- d. Trusses shall be of ample strength to maintain alignment of tracks and moving parts, and so designed that they shall safely retain steps and running gear, and in case of failure of track systems, retain step mechanism within guides and envelope of the truss.
 - e. The truss shall be designed to support the dead weight of the escalator and a full passenger load.
 - f. The deflection of the loaded truss shall not exceed one one-thousandths (1/1000) of the span under a live load of 320 pounds per 40-inch step.
 - g. The slip joint slide bearings shall be fabricated using three thirty-seconds (3/32) of an inch thick glass filled TFE bearing surface, one sliding on the other. The expansion joint filler shall be rubber cork composition or neoprene strip.
 - h. Provide a permanent identification on the truss for the centerline at both ends of the escalator and in both transition curves.
 - i. Provide permanent mark reflecting track system working point distances to both ends of the escalator trusses.
 - j. No intermediate supports are permitted for spans less than 50 feet.
2. Field Splices and Connections
 - a. Field splices shall be rigid, non-deforming, and shall maintain alignment.
 - b. Holes for attaching balustrade securing brackets shall be punched.
 - c. Field modification shall not compromise the paint and corrosion protection specified in the contract documents.
 3. Access Panels
 - a. Access panels for access to escalator parts for inspection and maintenance shall be provided.
 4. Intermediate Supports (where indicated on contract documents and verified by the Vertical Transportation Equipment Supplier)
 - a. Support shall be stub column and beam type bolted to wellway structure. Stub columns may be welded or bolted to the truss.
 - b. Support trusses using intermediate supports described above shall be provided. No other attachments to structure shall be permitted. Truss mounts, including bolts, angles, shims, bearing pads, and spring supports, as required to align and install escalators shall be provided.
 5. Provisions are to be made, if required, within the truss for attaching any finish required to enclose the same.
- K. Step Chain Tensioning Device
1. An automatic tensioning device to maintain tension under load and to compensate for wear shall be provided. The device shall be located within the truss at the lower end.



2. A means for individual fine adjustment of tension for each linkage shall be provided.
3. A pointer and scale shall be provided to gauge step chain tensioning and wear.
4. Bearings: if used, shall be rated: AFBMA L10, 200,000 hours.

L. Lubrication System Requirements

1. Step Chain

- a. All parts, other than sealed items, requiring lubrication shall be designed for an automatic or remote lubricating system. The system shall operate only when escalator is running and the amount of lubrication shall be fully adjustable. A reservoir with a low oil signal to the controller, and a minimum capacity of five (5) liter shall be provided.
- b. System shall be positive acting, located in escalator pit.
- c. Reservoir level indications shall be provided where lubricants are contained within housings, supply tanks and larger filler cups.
- d. Automatic Lubrication System shall be as manufactured by Castrol Industrial or approved equal.

2. Miscellaneous Lubrication

- a. Vertical Transportation Equipment Supplier shall furnish and mount near the lubricating system in the escalator controller room, a framed lubrication chart for each escalator. The chart shall show the location of each lubrication point, type of lubricant to be used, and the frequency of lubrication.
- b. Bearings
 - 1) Sealed bearings shall be used where possible.
 - 2) Bearings requiring manual lubrication shall be furnished with fittings to accommodate the use of a pressure gun for lubrication.
 - 3) Self-lubricating bearings or material other than ball or roller type bearings may be used where practical.

3. Manual Lubrication

- a. Location of manual lubrication points shall be easily accessible and available.

M. Annunciator

1. Escalators shall be provided with voice annunciators at the upper and lower ends for audible warning messages. Audible messages shall be per PSHIA standard.

N. Traffic Lights / Indicators

1. Escalator users shall be informed by means of indicator lights of the predetermined running direction of the escalator.
2. Two (2) circular cut outs, minimum diameter two and three quarter (2 ¾) inches. Shall be provided in the upper and lower right hand balustrade newels, each containing an inset red and green light. The green light



shall be illuminated at the entrance for escalator running direction and the red lamp shall have a horizontal white stripe and shall be illuminated at the exiting end. No incandescent lamps shall be permitted.

O. Lock Cylinders

1. All locks and keys shall be as per Program/Project Manager approval and shall accommodate PSHIA Standard cores.
2. Vertical Transportation Equipment Supplier shall verify with the Program/Project Manager that the requirements for hardware have not been amended or superseded.
3. Vertical Transportation Equipment Supplier shall provide the Program/Project Manager with length, finish, and camming requirements of each cylinder required.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Vertical Transportation Equipment Supplier shall install complete and operating escalators in accordance with manufacturer's instruction and approved shop drawings.
- B. Vertical Transportation Equipment Supplier shall provide all special tools to PSHIA.
- C. Escalators will be periodically inspected during the installation process by the Program/Project Manager and Owner/Owner's Representative. All requests made by the inspecting personnel are to be addressed by the installer to the satisfaction of the inspecting personnel.

3.02 FIELD TESTING

- A. General: After installation, the Vertical Transportation Equipment Supplier shall inspect and test each escalator and related equipment to the Program/Project Manager and PSHIA's satisfaction that operation of every part of the equipment complies with this specification and with applicable requirements of ASME/ANSI A17.1 including sound level criteria specified herein. Escalators will be inspected in accordance with the following:
 1. Vertical Transportation Equipment Supplier shall notify the Program/Project Manager seven (7) days prior to each separate scheduled test. Vertical Transportation Equipment Supplier shall perform testing in the presence of the Program/Project Manager. This test is in addition to those performed by The City of Phoenix Elevator Inspector.
 2. Vertical Transportation Equipment Supplier shall notify the appropriate local authorities having jurisdiction a minimum of seven (7) days in advance of final acceptance tests.



3. Vertical Transportation Equipment Supplier shall provide all instruments, materials, and labor required for tests specified herein.

B. Acceptance/Commissioning Testing Requirements

1. Testing shall be performed in accordance with ASME A17.2.3 procedures with the following additions or adaptations.
2. Vertical Transportation Equipment Supplier shall perform the following tests on each escalator without load:
 - a. Comb impact devices shall be tested and calibrated with an appropriate scale at both ends of the escalator in both the horizontal and vertical direction.
 - b. Brakes: Measure deceleration rate with no load over 5 consecutive stops in the down direction using test equipment designed to obtain this information.
 - c. Escalator shall produce no noise louder than sixty-five (65) decibels measured five (5) feet above the floor or stair level at the entrance combs at both ends with the escalator operating normally, either free running or under load. For multiple escalator installations, the noise measurements at each group shall be made with only the one (1) escalator unit under evaluation in operation. Ambient noise level shall not exceed forty-nine (49) decibels.
3. Vertical Transportation Equipment Supplier shall perform the following tests on each escalator under full load:
 - a. Each escalator shall have a full field load as specified in 2.01 B brake test performed on it. The stopping distance in the down direction shall meet all requirements of ASME A17.1.
 - b. Forty-eight test: the escalator shall operate continuously for 48 consecutive hours after the acceptance test with no faults. If any fault occurs that shuts the escalator down, the fault must be corrected and a new 24-hour test will begin.
4. If either the no load or full load brake tests fail, both tests must be repeated with the same torque setting on the brake for both no load and full load.
5. The functionality of the remote monitoring system, as described in these contract documents, shall be tested as part of these testing procedures.
6. Re-Inspection: If any equipment is found to be damaged or defective, or if the performance of the escalators does not conform to the requirements of the contract specifications or the Safety Code, no approval or acceptance of escalators shall be issued until all defects have been corrected. When the repairs and adjustments have been completed and the discrepancies corrected, the Engineer shall be notified and the escalators will be re-inspected. Rejected escalators shall not be used until they have been re-inspected and approved.



3.03 ADJUSTING, CLEANING AND PAINTING

- A. All equipment shall be adjusted prior to final testing and acceptance.
- B. Restore all exposed work soiled or damaged during installation to its original finish. Repair to match adjoining work prior to final acceptance.
- C. A thorough clean down of all escalators, externally and internally, shall be performed prior to escalators being operated for public use.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Common installation requirements for:
 - a. Piping systems.
 - b. Mechanical equipment.
 - 2. Requirements for the following:
 - a. Dielectric fittings.
 - b. Mechanical sleeve seals.
 - c. Sleeves.
 - d. Escutcheons.
 - e. Plumbing demolition.
 - f. Concrete bases for mechanical equipment.
 - g. Supports and anchorages for mechanical equipment.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01736 - Selective Demolition.
 - 5. Section 03200 – Concrete Reinforcement.
 - 6. Section 03300 – Cast-in-Place Concrete.
 - 7. Section 05500 – Metal Fabrications.
 - 8. Section 07850 - Through Penetration Firestopping System.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene Propylene Diene M-class rubber.
 - 2. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 3. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
- B. Definitions:
 - 1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces



immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

2. Exposed, Interior Installations: Exposed to view indoors.
 - a. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
 - a. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants.
 - a. Examples include above ceilings and in chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures.
 - a. Examples include installations within unheated shelters.

C. Reference Standards:

1. American Society of Mechanical Engineering (ASME):
 - a. ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
 - b. ASME B31.5 – Refrigeration Piping and Heat Transfer Components.
 - c. ASME B31.9 – Building Services Piping.
 - d. ASME B31.J – Standard Test Method for Determining Stress Intensification Factors (i-Factors) for Metallic Piping Components.
 - e. ASME B31.Q – Pipeline Personnel Qualification.
 - f. ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch.
 - g. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
2. American Welding Society (AWS):
 - a. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
 - b. AWS BHR – Brazing Handbook.
 - c. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - d. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe.
3. ASTM International (ASTM):
 - a. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM B 32 - Standard Specification for Solder Metal.
 - c. ASTM B 813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
 - d. ASTM B 828 - Standard Practice for Making Capillary Joints by Soldering of Copper Alloy Tube and Fittings.
4. City of Phoenix (COP):



- a. Phoenix Building Construction Code and Amendments.
- 5. Copper Development Association Inc. (CDA)
 - a. CDA A4015 - The Copper Tube Handbook.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- 2. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Coordination Drawings.
 - b. Certificates:
 - 1) Welding Certificates qualifying steel support welding procedures.
 - 2) Welding Certificates qualifying steel pipe welding procedures.
 - c. Special Procedure Submittals:
 - 1) Procedures to be used for pre-qualifying welders.
 - 2) Procedures to be used for pre-qualifying welding procedures.
 - d. Qualification Statements:
 - 1) Steel support welders' qualifications.
 - 2) Steel pipe welders' qualifications.



1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Welder Qualifications:
 - a. Prior to beginning to weld steel supports and steel pipe, submit the procedures to be used for pre-qualifying the welders to the Program/Project Manager for approval.
 - b. Steel Support Welders:
 - 1) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M for the procedures.
 - 2) Submit steel support welder qualifications certifying that the welders employed to perform steel support welding Work have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.



- c. Steel Pipe Welders:
 - 1) Qualify operators according to the requirements set forth in the ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M for the procedures.
 - 3) Submit steel pipe welder qualifications certifying that the welders employed to perform steel pipe welding Work have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - (1) Include certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

C. Certifications:

1. Welding Certificates:

- a. Prior to beginning to weld steel supports and steel pipe, submit the procedures to be used for pre-qualifying the welding procedures to the Program/Project Manager for approval.
- b. Steel Support Welding Certificates:
 - 1) For steel support welding procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the welding procedure qualification test records.
- c. Steel Pipe Welding Certificates:
 - 1) Qualify processes according to the requirements set forth in the ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Design Criteria:

1. Piping Systems:

- a. Plans, schematics, and diagrams included in the Contract Drawings indicate the general location and arrangement of piping systems.



- 1) The indicated locations and arrangements were used to size pipe and calculate friction losses, expansion, pump sizing, and other design considerations.
 - 2) Install piping as indicated unless deviations to the layout are approved by the Program/Project Manager on Coordination Drawings.
 - b. Select system components with pressure ratings equal to or greater than system operating pressure.
 2. Steel Pipe Welding:
 - a. Weld steel pipe in compliance with the provisions specified in the ASME B31 Series of standards (Code for Pressure Piping).
 3. Mechanical Equipment Electrical Characteristics:
 - a. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing by the Program/Project Manager and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified.
 - b. If minimum energy ratings or efficiencies are specified, provide equipment complying with these requirements.
- B. Materials:
1. Anchor Bolts:
 - a. Provide epoxy-coated anchor bolts complying with the requirements specified in Section 05500, Metal Fabrications.
 - 1) For factory-threaded pipe and pipe fittings, provide pipe threads complying with the requirements specified in ASME B1.20.1.
 2. Dielectric Fittings:
 - a. Provide combination dielectric fittings consisting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match the piping system materials.
 - b. Insulating Material:
 - 1) Provide insulating material suitable for the system fluid, pressure, and temperature.
 - c. Dielectric Unions:
 - 1) Provide factory-fabricated, dielectric union assemblies designed for a minimum working pressure of 250 psig at 180 degrees Fahrenheit.
 - d. Dielectric Flanges:
 - 1) Provide factory-fabricated, companion-flange assemblies designed for a minimum working pressure of either 150 or 300 psig as required to suit the system pressures.
 - e. Dielectric Couplings:



- 1) Provide galvanized steel dielectric couplings having inert and noncorrosive, thermoplastic linings; threaded ends; and designed for a minimum working pressure of 300-psig at 225 degrees Fahrenheit.
- f. Dielectric Nipples:
 - 1) Provided electroplated steel nipples having inert and noncorrosive, thermoplastic linings; plain, threaded, or grooved ends; and designed for a minimum working pressure of 300 psig at 225 degrees Fahrenheit.
3. Escutcheons and Floor Plates:
 - a. Provide manufactured wall and ceiling escutcheons and floor plates having an inside diameter sized to closely fit around the pipe, tube, and insulation of insulated piping, and an outside diameter that completely covers the opening.
 - b. One-Piece, Deep-Pattern Type:
 - 1) Provide deep-drawn, box-shaped one-piece brass escutcheons and floor plates having a polished chrome-plated finish.
 - c. One-Piece, Cast-Brass Type:
 - 1) Provide one-piece cast brass escutcheons and floor plates having a polished chrome-plated finish and a set screw.
 - d. Split-Casting, Cast-Brass Type:
 - 1) Provide split-cast brass escutcheons and floor plates having a polished chrome-plated finish and a concealed hinge and set screw.
4. Firestopping Materials:
 - a. Provide firestopping materials complying with the requirements specified in Section 07850 Through Penetration Firestopping System.
5. Leveling Grout:
 - a. Provide premixed, factory packaged grout recommended for interior and exterior applications by the manufacturer.
 - b. Design Mix:
 - 1) Provide non-shrink, nonmetallic, dry hydraulic-cement grout complying with the requirements for Grade B as specified in ASTM C 1107/C 1107M.
 - 2) Provide grout having a 28-day compressive strength of 5000 psi (34.5MPa).
 - 3) Provide post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous grout.
6. Joining Materials
 - a. For special joining materials not listed herein, provide joining materials as specified in other Division 15 Sections.



- b. Pipe Flange Gasket Materials:
 - 1) Unless the specific material is indicated to be otherwise, provide nonmetallic, flat, asbestos-free, pipe flange gasket materials complying with the requirements specified in ASME B16.21.
 - 2) Maximum Thickness: 1/8-inch, unless indicated otherwise.
- c. Plastic Pipe Flange Gasket:
 - 1) Unless indicated otherwise, provide the type and material of plastic pipe flange gasket, including bolts and nuts, as recommended by the piping system manufacturer.
- d. Solder Filler Metals:
 - 1) Provide solder filler metals consisting of lead-free alloys complying with the requirements specified in ASTM B 32, and including water-flushable flux complying with the requirements specified in ASTM B 813.
- e. Brazing Filler Metals:
 - 1) Unless otherwise indicated, provide BCuP Series or BAg1 brazing filler metals complying with the requirements specified in AWS A5.8/A5.8M.
- f. Welding Filler Metals:
 - 1) Provide welding filler metals complying with the requirements specified in AWS D10.12M/D10.12.
- g. Solvent Cements for Joining Plastic Piping:
 - 1) For ABS piping, provide solvents complying with the requirements specified in ASTM D 2235.
 - 2) For CPVC piping, provide solvents complying with the requirements specified in ASTM F 493.
 - 3) For PVC piping, provide solvents complying with the requirements specified in ASTM D 2564. Include primer according to ASTM F 656.
 - 4) For PVC to ABS piping transitions, provide solvents complying with the requirements specified in ASTM D 3138.
- 7. Mechanical Sleeve Seals:
 - a. Provide a modular sealing element unit to fill the annular space between a pipe and sleeve, and designed for field assembly.
 - b. Sealing Elements:
 - 1) Provide EPDM interlocking links shaped to fit the surface of the pipe.
 - 2) Include the type and number required for the pipe material and the size of the pipe.
 - c. Pressure Plates:
 - 1) Provide 2 stainless steel pressure plates for each sealing element.



- d. Connecting Bolts and Nuts:
 - 1) Provide stainless steel connecting of the length required to secure the pressure plates to the sealing elements.
 - 2) Include one bolt and nut set for each sealing element.
- 8. Pipe, Tube, and Fittings:
 - a. Provide pipe, tube, and fitting materials and use joining methods as specified in other Division 15 Sections.
 - b. Pipe Threads: ASME B1.20.1 for factory threaded pipe and pipe fittings.
- 9. Sleeves:
 - a. Galvanized Steel Sheet:
 - 1) Provide galvanized steel sheet sleeves fabricated from a round tube closed with a longitudinal welded joint.
 - 2) Minimum Wall Thickness: 0.0239-inch.
 - b. Steel Pipe:
 - 1) Provide galvanized Schedule 40 steel pipe sleeves having plain ends.
 - 2) Fabricated the pipe sleeves from Type E, Grade B steel complying with the requirements specified in ASTM A 53/A 53M.
 - c. Wall Pipe:
 - 1) Provide cast iron or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and, unless otherwise indicated, an integral waterstop.
 - d. Stack Sleeve Fittings:
 - 1) Provide manufactured, cast-iron stack sleeve fittings with an integral clamping flange.
 - a) For membrane flashing, include a clamping ring, bolts, and nuts.
 - b) Underdeck Clamp:
 - (1) Provide a clamping ring with set screws.

2.02 SOURCE QUALITY CONTROL

- A. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when smoke control systems, automatic shutoff for air distribution systems, smoke and fire dampers, medical gas and vacuum systems, or grease duct alternatives for this Contract are being installed and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify final equipment locations for roughing-in.

3.02 PREPARATION

- A. Demolition/Removal:
 - 1. Plumbing Demolition:
 - a. Comply with the general demolition requirements and procedures specified in Section 01732, Cutting and Patching, and Section 01736, Selective Demolition.
 - b. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1) Cap or plug remaining piping with the same or compatible piping material.
 - 2) Drain piping to be abandoned in place, and cap or plug the drained piping with the same or compatible piping material.
 - 3) Disconnect equipment to be removed, cap the services, and remove the equipment.
 - 4) Disconnect equipment to be removed and reinstalled, cap the services, and remove, clean, and store the equipment.
 - a) When appropriate, reinstall, reconnect, and make the equipment operational.
 - 5) Disconnect equipment to be removed and salvaged, cap the services, and remove the equipment and deliver it to the Owner.

3.03 INSTALLATION

- A. Piping System Installation:
 - 1. Install piping according to the requirements for the piping systems specified in other Division 15 Sections and the following:
 - a. Except in equipment rooms and service areas, install piping in concealed locations unless otherwise indicated.
 - b. Install both the piping indicated to be exposed and the piping in equipment rooms and service areas at right angles or parallel to building walls.
 - 1) Diagonal runs are prohibited unless specifically indicated otherwise.



- c. For piping installed above accessible ceilings, provide sufficient space to allow ceiling panel removal.
- d. Install piping so valves can be easily serviced.
- e. Install piping with the slopes indicated.
- f. Do not install piping so it sags or bends.
- g. At changes in direction and at branch connections, install fittings.
- h. Install piping so insulation installation is facilitated.
2. Install escutcheons for penetrations of walls, ceilings, and floors.
3. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

B. Piping Connections

1. Unless otherwise indicated, make piping connections as follows:
 - a. In NPS 2 (DN 50) and smaller piping, install unions adjacent to each valve and at the final connection to each piece of equipment.
 - b. In NPS 2-1/2 (DN 65) and larger piping, install flanges adjacent to flanged valves and at final connection to each piece of equipment.
2. Dry Piping Systems:
 - a. Install dielectric unions and flanges to connect piping materials of dissimilar metals.
3. Wet Piping Systems:
 - a. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

C. Piping Joint Construction:

1. Join pipe and fittings according to the requirements for the piping systems specified in other Division 15 Sections and the following:
 - a. Ream the ends of pipes and tubes, and remove burrs.
 - 1) Bevel the plain ends of steel pipe.
 - b. Remove scale, slag, dirt, and debris from the inside and outside of pipe and fittings before assembly.
2. Soldered Joints:
 - a. Construct soldered joints according to the requirements specified in ASTM B 828 or CDA A4015, The Copper Tube Handbook.
 - 1) Unless otherwise indicated, apply water-flushable flux complying with the requirements specified in ASTM B 813 to tube end.
 - 2) Provide lead-free solder alloy complying with the requirements specified in ASTM B 32.
3. Brazed Joints:
 - a. Construct brazed joints according to the requirements specified in "Pipe and Tube" Chapter of AWS BHR.



- b. Provide copper-phosphorus brazing filler metal complying with the requirements specified in AWS A5.8/A5.8M.
- 4. Threaded Joints:
 - a. Thread pipe with tapered pipe threads complying with the requirements specified in ASME B1.20.1.
 - 1) Cut threads full and clean using sharp dies.
 - 2) Ream threaded pipe ends to remove burrs and restore the full pipe inside diameter (ID).
 - b. Join threaded pipe, pipe fittings, and valves by applying appropriate tape or thread compound to the external pipe threads, unless dry seal threading is specified, and screwing the joints together.
 - c. Damaged Pipe or Pipe Fittings:
 - 1) Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - 2) Do not use pipe sections that have cracked or open welds.
- 5. Welded Joints:
 - a. Construct welded joints according to the requirements specified in AWS D10.12M/D10.12.
 - b. Only use processes and welding operators qualified according to the requirements specified in Paragraphs 1.05.B and 1.05.C.
- 6. Flanged Joints:
 - a. Select the appropriate gasket material, size, type, and thickness for the service application.
 - b. Assemble the joint in accordance with the manufacturer's recommendations.
 - 1) Position the flange gasket concentrically in the joint.
 - 2) Provide suitable lubricants on the flange bolt threads.
- D. Aboveground Exterior Wall Pipe Penetrations:
 - 1. Seal aboveground exterior wall pipe penetrations using sleeves and mechanical sleeve seals.
 - a. When selecting the sleeve sizes, allow an annular clear space of 1 inch between the pipe and sleeve for installing the mechanical sleeve seals.
 - 1) For sleeves smaller than 6 inches (150mm) in diameter, install steel pipe.
 - 2) For sleeves 6 inches (150mm) and larger in diameter, install cast-iron "wall pipes".
 - 2. Seal the aboveground exterior wall pipe penetrations using mechanical sleeve seals.
 - a. When selecting the mechanical sleeve seal, select the type and number of sealing elements required for the pipe material and size.



- b. Position the pipe in the center of the sleeve.
 - c. Assemble the mechanical sleeve seals, and install the seals in the annular space between the pipe and sleeve.
 - d. Tighten the bolts against the pressure plates so the sealing elements expand and make a watertight seal.
- E. Underground Exterior Wall Pipe Penetrations:
 - 1. Provide wall pipes as sleeves for underground exterior wall pipe penetrations.
 - a. When selecting the wall pipe sizes, allow an annular clear space of 1 inch between the pipe and wall pipe for installing the mechanical sleeve seals.
 - 2. Seal the underground exterior wall pipe penetrations using mechanical sleeve seals.
 - a. When selecting the mechanical sleeve seal, select the type and number of sealing elements required for the pipe material and size.
 - b. Position the pipe in the center of the sleeve.
 - c. Assemble the mechanical sleeve seals, and install the seals in the annular space between the pipe and sleeve.
 - d. Tighten the bolts against the pressure plates so the sealing elements expand and make a watertight seal.
- F. Fire-Barrier Penetrations:
 - 1. Maintain the indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.
 - 2. Seal pipe penetrations with firestop materials.
- G. Equipment Installation:
 - 1. Rough in the mechanical services for the equipment as specified in other Sections where the equipment roughing-in requirements are specified.
 - 2. When installing equipment, allow the maximum possible headroom unless specific mounting heights are indicated.
 - 3. In exposed interior spaces, install equipment level, plumb, and parallel and perpendicular to other building systems and components unless otherwise indicated.
 - 4. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components.
 - a. Connect equipment to facilitate ease of disconnection, and with minimum interference to other installations.
 - b. Extend grease fittings to accessible locations.
 - 5. When installing equipment, allow right of way to install piping at the required slope.



H. Concrete Bases:

1. Construct concrete bases of the dimensions indicated on the Contract Drawings or specified, but not less than 4 inches (100mm) larger in both directions than supported unit.
 - a. Provide 3000-psi 28-day compressive-strength concrete as specified in Section 03300, Cast-In-Place Concrete, and concrete reinforcement as specified in Section 03200, Concrete Reinforcement.
 - b. Connect the concrete base to the concrete floor by installing dowel rods.
 - 1) Unless otherwise indicated, install the dowel rods on 18-inch (450mm) centers around the full perimeter of the base.
2. Anchor supported equipment to the concrete base according to the equipment manufacturer's written instructions and applicable seismic codes.
 - a. Use the equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded to locate the anchorage devices.
 - b. Place and secure anchorage devices.
 - 1) Install epoxy-coated anchor bolts that extend through the concrete base and anchor into the structural concrete floor for supported equipment.
 - a) Install anchor bolts to the elevations required for proper attachment to the equipment.
 - b) Install anchor bolts according to the anchor-bolt manufacturer's written instructions.

I. Metal Supports and Anchorages:

1. Provide metal supports and anchorages to support and anchor mechanical materials and equipment at the location, alignment, and elevation required by the Contract Documents.
 - a. Accurately cut, fit, and place miscellaneous metal supports.
2. Field Welding:
 - a. Perform field welds in accordance with the requirements specified in AWS D1.1/D1.1M.

J. Wood Supports and Anchorages:

1. Provide wood supports and anchorages to support and anchor mechanical materials and equipment at the location, alignment, and elevation required by the Contract Documents.
 - a. Cut, fit, and place wood grounds, nailers, blocking, and anchorages.
 - b. Attach wood supports and anchorages to substrates as required to support applied loads.



2. Select fastener sizes that will not penetrate members if the opposite side will be exposed to view or will receive finish materials.
 - a. Tighten connections between members.
 - b. Install fasteners without splitting wood members.

K. Grouting

1. Mix and install leveling grout for equipment base bearing surfaces, pumps, and other equipment base plates and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of the grout.
4. Avoid air entrapment during placement of the grout.
5. Place grout to completely fill the equipment bases.
6. Place grout on concrete bases, and provide a smooth bearing surface for the equipment.
7. Place grout around anchors.
8. Cure placed grout.

3.04 REPAIR/RESTORATION

- A. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove the damaged or unserviceable portions and replace them with new products of equal capacity and quality.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when mechanical systems are being installed and tested, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Construction Manager at Risk or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.



2. Inspections:

- a. Special inspections by the Approved Agency will be made for smoke control systems, automatic shutoff for air distribution systems, smoke and fire dampers, medical gas and vacuum systems, and grease duct alternatives if they are provided under this Contract.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition.



SECTION 15052

BASIC PLUMBING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Plumbing demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.03 SUBMITTALS

- A. Welding certificates



1.04 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code—Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:



1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.03 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.04 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element

2.05 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.



- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.06 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.07 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PLUMBING DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.



4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.



- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.



- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.04 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Edit dielectric connection types in two subparagraphs below for each fluid.
 - 4. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 5. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.



- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.06 CONCRETE BASES

- A. Coordinate concrete work in this Article with Division 3 Section "Cast-in-Place Concrete" or "Cast-in-Place Concrete (Limited Applications)".
- B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 3

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.



3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.09 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15053

BASIC HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Plumbing demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.03 SUBMITTALS

- A. Welding certificates



1.04 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code—Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:



1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.03 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.04 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element

2.05 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.



- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.06 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.07 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.



- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.



- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.



3.03 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Edit dielectric connection types in two subparagraphs below for each fluid.
 - 4. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 5. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.05 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.



7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 3

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.08 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15060

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following:
 - a. Steel pipe hangers and supports.
 - b. Trapeze pipe hangers.
 - c. Metal framing systems.
 - d. Thermal-hanger shield inserts.
 - e. Fastener systems.
 - f. Equipment supports.
 - g. Grouting mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 05500 - Metal Fabrications.
 - 3. Section 15050 - Basic Mechanical Materials and Methods.
 - 4. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 5. Section 15815 - Metal Ducts.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
- B. Definitions:
 - 1. Standard terminology for pipe hangers and supports defined in MSS SP-90 applies to the Work of this Section.
 - 2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME B31.1 – Power Piping.
 - b. ASME B31.9 – Building Services Piping.



- c. ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
- 2. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M Structural Welding Code - Steel.
- 3. ASTM International (ASTM):
 - a. ASTM A 36/A 36M Standard Specification for Carbon Structural Steel.
 - b. ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - c. ASTM C 552 Standard Specification for Cellular Glass Thermal Insulation.
 - d. ASTM C 553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - e. ASTM C 1107/C 1107M Standard Specification for Packaged Dry, Hydraulic-Cement Grout.
- 4. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.
 - b. ANSI/MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.
 - c. MSS SP-89 - Pipe Hangers and Supports – Fabrication and Installation Practices.
 - d. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
- 5. Metal Framing Manufacturing Association (MFMA):
 - a. MFMA-4 - Metal Framing Standards Publication.
 - b. MFMA-103 - Guidelines for the Use of Metal Framing.
- 6. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-PA 1 Shop, Field, and Maintenance Painting of Steel.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of the mechanical hangers and supports with the installation of mechanical piping and equipment.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:



- a. Product Data:
 - 1) Trapeze pipe hanger components.
 - 2) Metal framing systems.
 - 3) Steel pipe hangers and supports.
 - 4) Thermal-hanger shield inserts.
 - 5) Powder-actuated fastener systems.
- b. Shop Drawings:
 - 1) Trapeze pipe hangers.
 - 2) Metal framing systems.
 - 3) Equipment supports.
- c. Certificates:
 - 1) Welding Certificates qualifying steel support welding procedures.
- d. Special Procedure Submittals:
 - 1) Procedures to be used for pre-qualifying welders.
 - 2) Procedures to be used for pre-qualifying welding procedures.
- e. Qualification Statements:
 - 1) Steel support welders' qualifications.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Welder Qualifications:

- a. Prior to beginning to weld steel hangers and supports, submit the procedures to be used for pre-qualifying the welders to the Program/Project Manager for approval.
 - 1) Qualify operators according to the requirements set forth in the ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M for the procedures.
 - 3) Submit steel hanger and support welder qualifications certifying that the welders employed to perform steel support welding Work have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

2. Professional Engineer Qualifications:



- a. Employ a licensed Professional Engineer, registered in the State of Arizona, having experience performing structural calculations.
- B. Certifications:
 - 1. Welding Certificates:
 - a. Prior to beginning to weld steel supports, submit the procedures to be used for pre-qualifying the welding procedures to the Program/Project Manager for approval.
 - b. Steel Support Welding Certificates:
 - 1) Qualify welding procedures according to the requirements set forth in the ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
 - 2) For steel support welding procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the welding procedure qualification test records.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Substitution Limitations:
 - 1. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
- B. Product Options:
 - 1. Subject to compliance with requirements, provide products by one of the manufacturers listed.

2.02 DESIGN CRITERIA:

- A. Specific hanger and support requirements are typically specified in other Sections where the piping systems and equipment are specified.
 - 1. For pipe hanger selections and applications that are not specified in the piping system Sections, comply with the requirements specified in MSS SP-69.
 - 2. For trapeze pipe hanger selections and applications that are not specified in the piping system Sections, comply with the requirements specified in MSS SP-69.
 - 3. For metal framing system selections and applications that are not specified in the piping system Sections, comply with the requirements specified in MFMA-103.



B. Load Distribution:

1. Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

C. Pipe Slopes:

1. Install hangers and supports so the indicated pipe slopes are achieved, and so the maximum pipe deflections allowed by ASME B31.1 for power piping and ASME B31.9 for building services piping are not exceeded.

D. Horizontal Piping Hangers and Supports:

1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of horizontal piping hangers and supports:
 - a. For suspension of non-insulated or insulated stationary pipes sized NPS 1/2 to NPS 30 (DN 15 to DN 750), provide adjustable, steel clevis hangers (MSS SP-58 Type 1).
 - b. For suspension of pipes sized NPS 4 to NPS 16 (DN 100 to DN 400) and requiring up to 4 inches of insulation due to 120 to 450 degree Fahrenheit contents, provide yoke-type pipe clamps (MSS SP-58 Type 2).
 - c. For suspension of pipes sized NPS 3/4 to NPS 24 (DN 20 to DN 600), having up to 4 inches of insulation, and requiring clamp flexibility, provide carbon or alloy steel, double bolt pipe clamps (MSS SP-58 Type 3).
 - d. For suspension of non-insulated stationary pipes sized NPS 1/2 to NPS 8 (DN 15 to DN 200), provide U-Bolts (MSS SP-58 Type 24).
 - e. For support of pipes sized NPS 4 to NPS 36 (DN 100 to DN 900) and having steel pipe base stanchion supports with cast-iron floor flanges, provide pipe saddle supports (MSS SP-58 Type 36).
 - f. For suspension of pipes sized NPS 1 to NPS 30 (DN 25 to DN 750) from 2 rods where longitudinal movement caused by expansion and contraction might occur, provide single pipe rolls (MSS SP-58 Type 41).
 - g. For support of pipes sized NPS 2 to NPS 42 (DN 50 to DN 1050) where longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary, provide complete pipe rolls (MSS SP-58 Type 44).

E. Vertical Piping Clamps:

1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of vertical piping clamps:



- a. For support of pipe risers sized NPS 3/4 to NPS 20 (DN 20 to DN 500), provide extension pipe or riser clamps (MSS SP-58 Type 8).
 - b. For support of pipe risers sized NPS 3/4 to NPS 20 (DN 20 to DN 500) where longer ends are required for riser clamps, provide carbon or alloy steel riser clamps (MSS SP-58 Type 42).
- F. Hanger-Rod Attachments:
 - 1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of hanger-rod attachments:
 - a. For adjustment up to 6 inches (150mm) due to heavy loads, provide steel turnbuckles (MSS SP-58 Type 13).
 - b. For piping installations with contents 120 to 450 degrees Fahrenheit (49 to 232 degrees Celsius), provide steel clevises (MSS SP-58 Type 14).
- G. Building Attachments:
 - 1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of building attachments:
 - a. For suspending pipe hangers from concrete ceilings, provide steel or malleable concrete inserts (MSS SP-58 Type 18).
 - b. For installations under roofs having bar-joists, provide top-beam C-clamps (MSS SP-58 Type 19) to attach hangers or supports to the top flange of the structural shape.
 - c. For attaching hangers or supports to the bottom flange of beams, channels, or angles, provide side-beam or channel clamps (MSS SP-58 Type 20).
 - d. For attaching hangers or supports to the center of the bottom flange of beams, provide center-beam clamps (MSS SP-58 Type 21).
 - e. For attaching hangers or supports to bottom of beams where the loads are considerable and the rod sizes are large, provide welded beam attachments (MSS SP-58 Type 22).
 - f. For attaching hangers or supports to structural shapes, provide C-clamps (MSS SP-58 Type 23).
 - g. For supporting pipes from below, or for suspending pipes from above using clips and rods, provide one of the following types of welded steel brackets selected according to the loads indicated:
 - 1) Light [750 pounds (340 kilograms)]: MSS SP-58 Type 31.
 - 2) Medium [1500 pounds (680 kilograms)]: MSS SP-58 Type 32.
 - 3) Heavy [3000 lb (1360 kg)]: MSS SP-58 Type 33.



- h. For attaching hangers or supports to the sides of steel or wooden beams, provide side beam brackets (MSS SP-58 Type 34).
 - i. For attaching hangers or supports to steel beams where flexibility at the beam is required, provide plate lugs (MSS SP-58 Type 57).
- H. Saddles and Shields:
 - 1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of saddles and shields:
 - a. To fill interior voids with insulation that matches adjoining insulation, provide steel pipe covering protection saddles (MSS SP-58 Type 39).
 - b. To prevent crushing the insulation, provide protection shields (MSS SP-58 Type 40) of the length recommended in writing by the protection shield manufacturer.
 - c. For supporting insulated pipe, provide thermal-hanger shield inserts.
- I. Spring Hangers and Supports:
 - 1. Except as otherwise specified in other Sections specifying piping systems or indicated on the Contract Drawings, provide the following types of spring hangers and supports:
 - a. For light loads where vertical movement does not exceed 1-1/4 inches (32mm), provide spring cushions (MSS SP-58 Type 48).
 - b. To equip Type 41 roll hangers with springs, provide spring-cushion roll hangers (MSS SP-58 Type 49).
 - c. To absorb expansion and contraction of the piping system from the base support, provide variable-spring base supports (MSS SP-58 Type 52).
- J. For piping and equipment hangers and supports that will not have a field applied finish, provide galvanized metallic coatings.
- K. Where attachments are in direct contact with copper tubing, apply nonmetallic coatings on the attachments to provide protection against electrolytic corrosion.
- L. For piping subject to scratching, provide padded hangers.
- M. Design supports for multiple pipes capable of supporting the combined weight of the supported systems, system contents, and test water.
- N. Design equipment supports capable of supporting the combined operating weight of the equipment, connected systems, and components supported.



- O. Design seismic-restraint hangers and supports for piping and equipment, and obtain approval of these special hangers and supports from the Authorities Having Jurisdiction.
- P. Where hangers and supports must be attached to concrete construction, provide powder-actuated fasteners or mechanical-expansion anchors instead of building attachments.

2.03 MANUFACTURED UNITS

- A. Vibration Isolation Devices:
 - 1. Provide vibration isolation devices complying with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- B. Duct Hangers and Supports:
 - 1. Provide duct hangers and supports complying with the requirements specified in Section 15815, Metal Ducts.
- C. Pipe Hangers and Supports:
 - 1. Provide factory-fabricated steel pipe hangers and supports of Types 1 through 58 as specified in MSS SP-58.
 - 2. Galvanized, Metallic Coatings:
 - a. Provide pre-galvanized or hot dipped galvanizing coatings.
 - 3. Nonmetallic Coatings:
 - a. Provide plastic coatings, jackets, or liners.
 - 4. Padded Hangers:
 - a. Provide hangers with fiberglass or other pipe insulation pads or cushions to support the bearing surface of the piping.
 - 5. Manufacturers:
 - a. B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
 - b. Globe Pipe Hanger Products, Inc.; www.globepipehanger.com.
 - c. Grinnell Mechanical Products, Tyco Fire Products, LP; www.grinnell.com.
 - d. National Pipe Hanger Corporation, www.nationalpipehanger.com.
 - e. Piping Technology and Products, Inc., www.pipingtech.com.
 - f. Approved equal.
 - 6. Submit Product Data for steel pipe hangers and supports to the Program/Project Manager for approval.
- D. Trapeze Pipe Hangers:
 - 1. Provide Type 59 shop or field fabricated pipe support assemblies as specified in MSS SP-69, made from structural-steel shapes, and having



hanger rods, nuts, saddles, and U-bolts complying with the requirements specified in MSS SP-58.

2. Submit Product Data for trapeze pipe hanger components to the Program/Project Manager for approval.
3. Submit Shop Drawings for the trapeze pipe hangers, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.
 - a. Show fabrication and installation details.
4. Submit calculations for the trapeze pipe hangers, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.

E. Metal Framing Systems:

1. Provide shop or field fabricated pipe support assemblies as specified in MFMA-4, made from steel channels and other components.
2. Coatings:
 - a. Provide the manufacturer's standard finish, unless bare metal surfaces are indicated in the Contract Documents.
 - b. Nonmetallic Coatings:
 - 1) Provide plastic coatings, jackets, or liners.
3. Manufacturers:
 - a. B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
 - b. Power-Strut Division; Tyco International, Ltd., www.power-strut.com/.
 - c. Thomas & Betts Corporation, www.tnb.com.
 - d. Unistrut Corp.; Tyco International, Ltd.; www.unistrut.com.
4. Submit Product Data for metal framing system components to the Program/Project Manager for approval.
5. Submit Shop Drawings for the metal framing systems, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.
 - a. Show fabrication and installation details.
6. Submit calculations for the metal framing systems, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.

F. Thermal-Hanger Shield Inserts:

1. Provide sheet metal encased insulated hanger shield inserts.
2. Compressive Strength: 100 psig, minimum.
3. Insulation:
 - a. For cold piping, provide water-repellent treated calcium silicate complying with the requirements for Type I as specified in



- ASTM C 533, or cellular glass complying with the requirements for Type II as specified in ASTM C 552 with a vapor barrier.
- b. For hot piping, provide water-repellent treated calcium silicate complying with the requirements for Type I as specified in ASTM C 533, or cellular glass complying with the requirements for Type II as specified in ASTM C 552.
4. For Trapeze or Clamped Systems:
 - a. Provide inserts and shields that cover the entire circumference of the pipe.
 5. For Clevis or Band Hangers:
 - a. Provide inserts and shields that cover the lower 180 degrees of the pipe.
 6. Insert Length:
 - a. For piping operating below the ambient air temperature, provide inserts that extend 2 inches beyond the sheet metal shield.
 7. Manufacturers:
 - a. Carpenter & Paterson, Inc.; www.carpenterandpaterson.com.
 - b. ERICO/Michigan Hanger Co., www.erico.com.
 - c. Pipe Shields, Inc.; Piping Technology and Products, Inc.; www.pipingtech.com/PipeShields/.
 8. Submit Product Data for thermal-hanger shield inserts to the Program/Project Manager for approval.
- G. Fastener Systems
1. Verify the suitability of fasteners for use in lightweight concrete and concrete slabs less than 4 inches thick.
 2. Powder-Actuated Fasteners:
 - a. Provide threaded steel stud powder-actuated fasteners designed for use in hardened Portland cement concrete, and having pull-out, tension, and shear capacities appropriate for the loads supported and the building materials where they are used.
 - b. Manufacturers:
 - 1) Hilti, Inc.; www.hilti.com.
 - 2) ITW Ramset/Red Head, www.ramset-redhead.com.
 - 3) Masterset Fastening Systems, Inc.; www.simpsonanchors.com.
 - 4) Powers Fasteners, www.powers.com.
 - c. Submit Product Data for powder-actuated fastener systems to the Program/Project Manager for approval.
 3. Mechanical-Expansion Anchors:
 - a. Provide insert-wedge-type stainless steel mechanical expansion anchors designed for use in hardened Portland cement concrete, and



having pull-out, tension, and shear capacities appropriate for the loads supported and the building materials where they are used.

b. Manufacturers:

- 1) B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
- 2) Hilti, Inc.; www.hilti.com.
- 3) ITW Ramset/Red Head, www.ramset-redhead.com.
- 4) Powers Fasteners, www.powers.com.

H. Equipment Supports:

1. Provide welded, shop or field fabricated equipment supports fabricated from structural-steel shapes.
2. Submit Shop Drawings for the equipment supports, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.
 - a. Show fabrication and installation details.
3. Submit calculations for the equipment supports, signed and sealed by a qualified Professional Engineer, to the Program/Project Manager for approval.

2.04 MATERIALS:

A. Structural Steel:

1. Provide black and galvanized structural steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M.
2. Tor trapeze hangers for pipe and equipment supports, provide structural-steel shapes and plates complying with the requirements specified in Section 05500, Metal Fabrications.

B. Grout:

1. Provide grout complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.

C. Provide hangers and supports complete with the necessary inserts, bolts, rods, nuts, washers, and other accessories.

2.05 SHOP FABRICATION:

A. Metal Fabrications

1. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
2. Fit exposed connections together to form hairline joints.



- a. For connections that cannot be shop welded because of shipping size limitations, make provisions to weld the connections in the field.
3. Finish welds at exposed connections so no roughness shows after finishing, and the contours of welded surfaces match adjacent contours.

B. Equipment Supports:

1. Fabricate equipment supports from welded structural steel shapes.
2. Fabricate structural steel stands to suspend equipment from the overhead structure, or to support the equipment above the floor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Examine the locations to receive mechanical hangers and supports.

B. Evaluation and Assessment:

1. Verify that the locations to receive mechanical hangers and supports are ready for the Work of this Section.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect the areas surrounding the locations to receive mechanical hangers and supports from damage resulting from installation of the hangers and supports.
2. Protect adjacent areas from weld spatter and paint stains.

B. Surface Preparation:

1. Grouting:
 - a. Grout surfaces indicated to receive grout as specified in Section 15050, Basic Mechanical Materials and Methods.

3.03 INSTALLATION

A. Steel Pipe Hangers:

1. Provide the hangers, supports, clamps, and attachments required to properly support piping from the building structure.
 - a. Comply with the requirements specified in MSS SP-69 and MSS SP-89.

B. Trapeze Pipe Hangers:



1. To support parallel runs of horizontal piping arranged and grouped together, provide field-fabricated trapeze pipe hangers that comply with the requirements specified in MSS SP-69 and MSS SP-89.
 - a. Field fabricate the trapeze pipe hangers from steel shapes complying with the requirements specified in ASTM A 36/A 36M and selected for the loads being supported.
 - 1) Weld steel according to the requirements specified in AWS D1.1/D1.1M.
 - b. Support pipes of various sizes together.
 - c. Space the trapeze pipe hangers for the smallest pipe size, or install intermediate supports for the smaller diameter pipes as specified for individual pipe hangers.
- C. Metal Framing Systems:
 1. Field-assemble metal framing systems to support parallel runs of piping grouped together.
- D. Thermal-Hanger Shields:
 1. Provide pipe hangers or shields for insulated piping.
- E. Fastener Systems:
 1. Install powder-actuated fasteners and mechanical-expansion anchors in concrete after the concrete is placed and completely cured.
 - a. To install powder-actuated fasteners, employ operators licensed by the powder-actuated tool manufacturer.
 - b. Install powder-actuated fasteners according to the powder-actuated tool manufacturer's operating manual.
 - c. Install mechanical-expansion anchors according to anchor manufacturer's written instructions.
- F. Building Attachments:
 1. Install building attachments within concrete slabs, or attach them to structural steel.
 - a. Install concrete inserts before the concrete is placed.
 - b. Fasten concrete inserts to the concrete forms, and install reinforcing bars through openings at top of inserts.
 2. Install additional attachments at concentrated loads, including at the following:
 - a. Valves, flanges, and strainers.
 - b. Pipe sized NPS 2-1/2 (DN 65) and larger.
 - c. Changes in direction of piping.



G. Equipment Support Installation:

1. Suspend equipment from the overhead structure, or support the equipment above the floor, on structural steel stands.
 - a. To prevent swaying, provide lateral bracing for equipment hangers and supports.
 - b. To provide a smooth bearing surface for equipment, place grout under equipment supports.

H. Insulated Piping:

1. Attach clamps and spacers to the insulated piping.
 - a. For piping operating above ambient air temperature, the clamps may project through the insulation.
 - b. For piping operating below ambient air temperature, provide thermal-hanger shield inserts with clamps sized to match the outside diameter (OD) of the insert.
 - c. Do not exceed the pipe stress limits specified in ASME B31.1 for power piping and in ASME B31.9 for building services piping.
2. Where insulation without vapor barrier is indicated, provide protection saddles (MSS SP-58 Type 39).
 - a. Fill interior voids with insulation that matches the adjoining insulation.
3. For cold piping with vapor barrier, provide protective shields (MSS SP-58 Type 40) spanning an arc of 180 degrees.
 - a. Provide shields having not less than the following dimensions for pipe:
 - 1) For pipe sizes NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long, and 0.048 inch thick.
 - 2) For pipe size NPS 4 (DN 100): 12 inches long, and 0.06 inch thick.
 - 3) For pipe sizes NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long, and 0.06 inch thick.
 - 4) For pipe sizes NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long, and 0.075 inch thick.
 - 5) For pipe sizes NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long, and 0.105 inch thick.
4. For pipe sizes NPS 8 (DN 200) and larger, include wood inserts.
5. Insert Material Length:
 - a. Provide insert at least as long as the protective shield.
6. Thermal-Hanger Shields:
 - a. Provide thermal-hanger shields with insulation the same thickness as the piping insulation.

I. Special Techniques:

1. Field Welding:



- a. Field weld connections on metal fabrications that cannot be shop welded because of shipping size limitations.
 - 1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2) Comply with the requirements for shielded metal arc welding procedures specified in AWS D1.1/D1.1M to insure the appearance and quality of welds, and the methods used in correcting welding work, are best practices.
 - 3) Obtain fusion without undercut or overlap.
 - 4) Remove welding flux immediately.
- b. Finish the welds at exposed connections so no roughness shows after finishing, and contours of welded surfaces match adjacent contours.
2. Thermal and Seismic Movement:
 - a. Install hangers and supports so controlled thermal and seismic movement of the piping systems can occur; the pipe is free to move between the pipe anchors; and the action of expansion joints, expansion loops, expansion bends, and similar units is facilitated.
 - b. To prevent swaying, provide lateral bracing for pipe hangers and supports.

3.04 REPAIR/RESTORATION

- A. Touch Up Painting:
 1. Provide the same materials used for shop painting.
 2. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Clean field welds and areas of abraded shop paint.
 - b. Paint the exposed areas immediately after erecting the hangers and supports.
 - c. Apply paint by brush or spray.
 - d. Provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces:
 1. Clean welds, bolted connections, and abraded areas; and apply galvanizing-repair paint as specified in ASTM A 780.

3.05 ADJUSTING

- A. Hanger Adjustments:
 1. Adjust hangers to distribute the loads on attachments equally, and to achieve indicated pipe slope.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15065

MOTORS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. General requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating electric current (AC) power systems up to 600 Volts.
- B. Products Supplied But Not Installed Under This Section:
 - 1. The motors specified in this Section will be installed at the mechanical equipment manufacturer's factory, or will be shipped separately by the mechanical equipment manufacturer for field installation under other Sections.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
- B. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 841 – IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors-Up to and Including 370 kW (500 hp).
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1 – Motors and Generators.
 - 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the features of motors, installed units, and accessory devices to be compatible with the following:
 - a. Motor controllers.
 - b. Torque, speed, and horsepower requirements of the load.



- c. Ratings and characteristics of the supply circuit and the required control sequence.
- d. Ambient and environmental conditions of the installation location.

PART 2 PRODUCTS

2.01 MOTORS

- A. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for motors in NFPA 70.
- B. Performance:
 - 1. Motor Characteristics:
 - a. Duty:
 - 1) Provide motors rated for continuous duty at an ambient temperature of 40 degrees Celsius and at an altitude of 3300 feet (1000m) above sea level.
 - b. Capacity and Torque Characteristics:
 - 1) Provide motors having sufficient capacity and torque characteristics to start, accelerate, and operate the connected loads at the designated speeds, at the installed altitude and environment, with the indicated operating sequence, and without exceeding the nameplate ratings or considering the service factor.
- C. Design Criteria:
 - 1. Provide motors that comply with the requirements specified in this Section except when stricter requirements are specified in the Mechanical Equipment Schedules on the Contract Drawings or in other Sections.
 - 2. Unless otherwise indicated in the Contract Documents, provide motors that comply with the requirements specified in NEMA MG 1.
 - 3. For severe-duty motors, provide motors that comply with the requirements specified in IEEE 841.
- D. Materials:
 - 1. Polyphase Motors:
 - a. Provide polyphase medium induction motors that comply with the requirements for Design B specified in NEMA MG 1.
 - b. Efficiency:



- 1) Provide polyphase motors that are energy efficient as defined in NEMA MG 1.
- c. Service Factor:
 - 1) Provide polyphase motors having a service factor of 1.15.
- d. Multispeed Motors:
 - 1) Provide variable torque motors.
 - a) For motors having a 2:1 speed ratio, provide a consequent pole, single winding.
 - b) For motors having other than a 2:1 speed ratio, provide a separate winding for each speed.
- e. Multispeed Motors:
 - 1) Provide a separate winding for each speed.
- f. Rotor:
 - 1) Provide a random-wound, squirrel cage rotor.
- g. Bearings:
 - 1) Provide re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- h. Temperature Rise:
 - 1) Provide motors rated for a temperature rise matching their insulation rating.
- i. Insulation:
 - 1) Provide motors having Class F insulation.
- j. Code Letter Designation:
 - 1) For motors rated for 15 horsepower (HP) and larger, provide motors having either NEMA starting Code F or Code G.
 - 2) For motors rated at less than 15 horsepower (HP), provide motors having the manufacturer's standard starting characteristic.
- k. Enclosure Material:
 - 1) For motor frame sizes 324T and larger provide cast iron enclosures.
 - 2) For motor frame sizes smaller than 324T provide rolled steel enclosures.
2. Polyphase Motors Subject to Additional Requirements:
 - a. For motors used with reduced-voltage and multispeed controllers, match the wiring connection requirements for the controller with the required motor leads.
 - 1) Provide terminals suited to the control method in the motor terminal box.
 - b. For motors used with variable frequency controllers, coordinate the ratings, characteristics, and features with the controller manufacturer, and have them approved by the controller manufacturer and comply with the following requirements:
 - 1) Windings:
 - a) Provide windings of copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist



transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

- 2) Energy-Efficient and Premium-Efficient Motors:
 - a) For energy-efficient and premium-efficient motors, provide motors rated for a Class B temperature rise, and having Class F insulation.
- 3) Inverter-Duty Motors:
 - a) For inverter-duty motors, provide motors rated for a Class F temperature rise, and having Class H insulation.
- 4) Thermal Protection:
 - a) Provide thermal protection complying with the requirements for thermally protected motors specified in NEMA MG 1.
- c. Severe-Duty Motors:
 - 1) Provide severe-duty motors complying with the requirements specified in IEEE 841, with a service factor of 1.15, minimum.
3. Single-Phase Motors:
 - a. For single-phase motors larger than 1/20 horsepower (HP) provide one of the following features to suit the starting torque and the requirements of the specific motor application:
 - 1) Permanent-split capacitor.
 - 2) Split phase.
 - 3) Capacitor start, inductor run.
 - 4) Capacitor start, capacitor run.
 - b. For single-phase motors 1/20 horsepower (HP) and smaller, provide the shaded-pole type.
 - c. Multispeed Motors:
 - 1) For multispeed motors, provide variable-torque, permanent-split-capacitor type.
 - d. Bearings:
 - 1) Provide pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - e. Thermal Protection:
 - 1) Provide internal protection that automatically opens the power supply circuit to the motor when the winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation.
 - 2) Provide a thermal-protection device that automatically resets when the motor temperature returns to the normal range.

PART 3 EXECUTION

NOT USED

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15070

MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for mechanical sound, vibration, and seismic controls, including the following:
 - a. Isolation pads.
 - b. Isolation mounts.
 - c. Restrained elastomeric isolation mounts.
 - d. Spring isolators.
 - e. Restrained spring isolators.
 - f. Housed spring mounts.
 - g. Elastomeric hangers.
 - h. Spring hangers.
 - i. Spring hangers with vertical-limit stops.
 - j. Pipe riser resilient supports.
 - k. Resilient pipe guides.
 - l. Channel support systems.
 - m. Restraint cables.
 - n. Hanger rod stiffeners.
 - o. Bushings for floor-mounted equipment anchor bolts.
 - p. Resilient isolation washers and bushings.
 - q. Anchor bolts.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01400 - Quality Requirements.
3. Section 07720 – Roof Accessories.
4. Section 15140 – Domestic Water Piping.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. HVAC: Heating, Ventilating, and Air-Conditioning.
2. ICC-ES: International Code Council – Evaluation Service.

B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M 251 - Plain and Laminated Elastomeric Bridge Bearings.
2. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
3. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M Structural Welding Code - Steel.
4. ASTM International (ASTM):
 - a. ASTM A 492 - Standard Specification for Stainless Steel Rope Wire.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. Manufacturers Standardization Society (MSS):
 - a. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
7. Metal Framing Manufacturing Association (MFMA):
 - a. MFMA-4 - Metal Framing Standards Publication.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. 10 days before sound, vibration, and seismic controls are to be installed, give notice to those performing other construction work related to the installation, such as to those performing work that must be supported by or that will provide support of the sound, vibration, and seismic controls, to allow such items to be introduced or furnished before the controls are installed.
2. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

B. Sequencing:



1. Sequence the installation of sound, vibration, and seismic controls to follow construction of supporting concrete and masonry load bearing walls and concrete foundations.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Vibration Isolators:
 - a) Vibration isolation pads.
 - b) Vibration isolation mounts.
 - c) Vibration isolation restrained mounts.
 - d) Spring isolators.
 - e) Restrained spring isolators.
 - f) Housed spring mounts.
 - g) Elastomeric hangers.
 - h) Spring hangers.
 - i) Spring hangers with vertical-limit stops.
 - j) Pipe riser resilient support.
 - k) Resilient pipe guides.
 - 2) Seismic-Restraint Devices:
 - a) Channel support systems.
 - b) Restraint cables.
 - c) Hanger rod stiffeners.
 - d) Bushings for floor-mounted equipment anchor bolts.
 - e) Resilient isolation washers and bushings.
 - f) Anchor bolts.
 - b. Certificates:
 - 1) Welding Certificates qualifying sound, vibration, and seismic control welding procedures.
 - c. Delegated Design Submittals:
 - 1) Methods for installing each seismic-restraint device or component approved by an acceptable agency.
 - d. Special Procedure Submittals:
 - 1) Seismic-restraint device preapprovals, independent test results, or calculations indicating maximum seismic-restraint ratings.
 - 2) Procedures to be used for pre-qualifying welders.
 - 3) Procedures to be used for pre-qualifying welding procedures.
 - e. Qualification Statements:



- 1) Professional Engineer's qualifications.
- 2) Sound, vibration, and seismic control welders' qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Load and Deflection Test Reports.
 - 2) Seismic-restraint device preapprovals, independent test results, or calculations indicating maximum seismic-restraint ratings.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.

B. Qualifications:

1. Code-Required Approved Agency for Performing Special Inspections:
 - a. To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency having the qualifications specified in Section 01400, Quality Requirements.
2. Testing and Inspection Agency Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ an independent Testing and Inspection Agency having the qualifications specified in Section 01400, Quality Requirements
3. Professional Engineer Qualifications:
 - a. Employ a licensed Professional Engineer, registered in the State of Arizona, who has experience performing sound, vibration, and seismic calculations to design the sound, vibration, and seismic controls and to perform the required calculations.
 - b. Submit the Professional Engineer's qualifications to the Program Manager for approval.
4. Welder Qualifications:



- a. Prior to beginning to weld the sound, vibration, and seismic controls, submit the procedures to be used for pre-qualifying the welders to the Program/Project Manager for approval.
- b. Sound, Vibration, and Seismic Controls Welders:
 - 1) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M for the procedures.
 - 2) Submit sound, vibration, and seismic controls welder qualifications certifying that the welders employed to perform steel support welding Work have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records that indicate each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

C. Certifications:

1. Welding Certificates:

- a. Prior to beginning to welding associated with the sound, vibration, and seismic controls, submit the procedures to be used for pre-qualifying the welding procedures to the Program/Project Manager for approval.
- b. Sound, Vibration, and Seismic Control Welding Certificates:
 - 1) For sound, vibration, and seismic control welding procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the welding procedure qualification test records.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

- 1. Ensure that materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - a. Deliver anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time so that the Work is not delayed.
- 2. Ship small parts, such as bolts, nuts, washers, pins, fillers, and small connecting plates and anchors, in boxes, crates, or barrels.
 - a. Pack each length and diameter of bolt and each size of nut and washer separately.
 - b. Plainly mark an itemized list and description of the contents on the outside of each container.



- B. Storage and Handling Requirements:
 - 1. Store and handle sound, vibration, and seismic controls as recommended by the sign panel manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Substitution Limitations:
 - 1. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
- B. Product Options:
 - 1. Subject to compliance with requirements, provide products by one of the manufacturers listed.

2.02 REGULATORY REQUIREMENTS:

- A. Comply with the seismic-restraint requirements in the ICC International Building Code (IBC), unless the requirements in this Section are more stringent.
- B. Provide seismic-restraint devices having horizontal and vertical load testing and analysis showing the maximum seismic-restraint ratings.
 - 1. If available, provide seismic-restraint devices having bearing anchorages preapproved by the International Code Council – Evaluation Service (ICC-ES), or preapproved by another agency acceptable to the Authorities Having Jurisdiction (AHJ).
 - 2. If preapproved ratings are not available, seismic-restraint devices having bearing anchorage ratings based on independent testing are preferred to seismic-restraint devices whose ratings are based on calculations.
 - a. Calculations, including combining shear and tensile loads, to support seismic-restraint designs must be signed and sealed by a qualified Professional Engineer.
 - 3. Submit seismic-restraint device preapprovals, independent test results, or calculations indicating maximum seismic-restraint ratings to the Program/Project Manager for approval.
 - a. Vibration isolation and seismic-restraint calculations and details submitted to indicate compliance with performance requirements and design criteria must include analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.



2.03 PERFORMANCE

- A. Seismic-Restraint Loading:
 - 1. Provide seismic-restraint devices complying with the requirements for the following design parameters as defined in the International Building Code (IBC):
 - a. Site Class: D.
 - b. Assigned Seismic Use Group or Building Category: IV.
 - 1) Component Importance Factor: 1.5.
 - 2) Component Response Modification Factor: 1.5.
 - 3) Component Amplification Factor: 1.0.
 - 2. Design Spectral Response Acceleration at Short Periods (0.2 Second): 75 percent.
 - 3. Design Spectral Response Acceleration at 1-Second Period: 50 percent.

2.04 DESIGN CRITERIA

- A. The locations of HVAC and plumbing equipment are shown on the Contract Drawings.
- B. Seismic-Restraint Devices:
 - 1. Expansion-type anchor bolts for non-isolated equipment in excess of 10 horsepower (7.46 kW) are not permitted by SEI/ASCE 7.
 - 2. Provide seismic-restraint devices having the rated strengths, features, and applications defined in reports furnished by an agency acceptable to the Authorities Having Jurisdiction (AHJ).
 - 3. Structural Safety Factor:
 - a. Provide seismic-restraint device components having the strength in tension and shear, and a pullout force, at least 4 times the maximum seismic forces to which they will be subjected.
 - 4. Strength of Support and Seismic-Restraint Assemblies:
 - a. Where not indicated in the Contract Documents, select the sizes of components so their strength will be adequate to carry present and future static and seismic loads within the specified loading limits.
- C. Submit Product Data for the products proposed for the Work of this Section to the Program/Project Manager for approval.

2.05 MANUFACTURED UNITS

- A. Vibration Isolators:
 - 1. Vibration Isolation Pads:



- a. Provide vibration isolator pads fabricated from resilient material arranged in single or multiple layers of sufficient stiffness to ensure uniform loading over the pad area.
 - 1) Resilient Material: Oil- and water-resistant neoprene.
 - 2) Mold pads with a nonslip pattern.
 - b. Factory-cut the pads to sizes that match the requirements of the equipment supported, and provide galvanized-steel base plates.
 - c. For supported or suspended HVAC equipment, provide 1 inch thick neoprene pads.
 - d. For supported or suspended plumbing equipment, provide 1/2 inch thick neoprene pads.
2. Vibration Isolation Mounts:
- a. Provide double-deflection type vibration isolator mounts having a cast-ductile-iron or welded steel housing containing 2 separate and opposing, molded isolator elements that prevent a central threaded element and attachment hardware from contacting the housing during normal operation.
 - 1) Provide-molded isolator elements fabricated from oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene.
 - a) Neoprene:
 - (1) Provide shock-absorbing materials compounded according to the requirements specified in AASHTO M 251.
 - b. For bolting the mounts to the isolated equipment, provide a factory-drilled, encapsulated top plate; and for bolting the mounts to the structure provide a base plate.
 - c. Color-code the vibration isolator mounts to indicate the capacity range of each mount, or otherwise identify the capacity ranges.
3. Restrained Vibration Isolation Mounts:
- a. Provide all-directional mountings having seismic restraint, and consisting of a cast-ductile-iron or welded steel housing containing 2 separate and opposing, isolator elements that prevent a central threaded element and attachment hardware from contacting the housing during normal operation.
 - 1) Provide-isolator elements fabricated from oil-resistant rubber or neoprene.
 - a) Neoprene:
 - (1) Provide shock-absorbing materials compounded according to the requirements specified in AASHTO M 251.
4. Spring Isolators:



- a. Provide freestanding, laterally stable, open-spring isolators complying with the following requirements:
 - 1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at the rated load.
 - 2) Minimum Additional Travel: 50 percent of the required deflection at the rated load.
 - 3) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 4) Overload Capacity: Capable of supporting 200 percent of the rated load, fully compressed, without deformation or failure.
 - b. Base Plates:
 - 1) For bolting the spring isolators to the structure, provide factory-drilled base plates having a 1/4-inch thick rubber isolator pad bonded to the underside of the base plate.
 - 2) Provide base plates that limit the floor load to 500 psig.
 - c. Top Plate and Adjustment Bolt:
 - 1) To fasten and level the isolated equipment to the spring isolator, provide a threaded top plate with an adjustment bolt and cap screw.
5. Restrained Spring Isolators:
- a. Provide freestanding, open-spring isolators with seismic or limit-stop restraint consisting of a steel housing with resilient vertical-limit stops that prevent the spring from extending when weight is removed, and that comply with the following requirements:
 - 1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at the rated load.
 - 2) Minimum Additional Travel: 50 percent of the required deflection at the rated load.
 - 3) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 4) Overload Capacity: Capable of supporting 200 percent of the rated load, fully compressed, without deformation or failure.
 - 5) Minimum Deflection: 1.0 inch.
 - b. Base Plates:
 - 1) For bolting the spring isolators to the structure, provide factory-drilled base plates having a 1/4-inch thick neoprene or rubber isolator pad bonded to the underside of the base plate.
 - 2) Provide an adjustable equipment mounting and leveling bolt that is also capable of acting as blocking during installation.
 - c. Restraint:



- 1) Provide a seismic or limit stop as required by the equipment and the Authorities Having Jurisdiction (AHJ).
6. Housed Spring Mounts:
 - a. Provide housed spring isolators having integral seismic snubbers, and complying with the following requirements:
 - 1) Housing:
 - a) To provide all-directional seismic restraint, provide a ductile iron or steel housing.
 - 2) Base:
 - a) Provide a factory-drilled base for bolting the housed spring isolator to the structure.
 - 3) Snubbers:
 - a) To allow a maximum travel of 1/4-inch (6mm) up or down before a resilient collar is contacted, provide vertically adjustable snubbers.
7. Elastomeric Hangers:
 - a. Provide single or double-deflection type elastomeric hangers fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings that have threaded connections for hanger rods.
 - b. Color-code the elastomeric hangers to indicate the capacity range of each hanger, or otherwise identify the capacity ranges.
8. Spring Hangers:
 - a. Provide combination coil-spring and elastomeric-insert hangers complying with the following requirements, and having the spring and insert in compression:
 - 1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at the rated load.
 - 2) Minimum Additional Travel: 50 percent of the required deflection at the rated load.
 - 3) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 4) Overload Capacity: Capable of supporting 200 percent of the rated load, fully compressed, without deformation or failure.
 - b. Frame:
 - 1) Provide a steel frame designed to connect to threaded hanger rods, and allow a maximum of 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 - c. Spring and Bushing Support:
 - 1) To support a spring and bushing projecting through the bottom of the frame, provide a molded, oil-resistant rubber or neoprene element in a steel-washer-reinforced cup.



- d. Hanger Rod Cap:
 - 1) To ensure concentricity between the hanger rod and the support spring coil, provide a self-centering hanger rod cap.
- 9. Spring Hangers with Vertical-Limit Stops:
 - a. Provide combination coil-spring and elastomeric-insert hangers complying with the following requirements, and having a vertical-limit stop and the spring and insert in compression:
 - 1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at the rated load.
 - 2) Minimum Additional Travel: 50 percent of the required deflection at the rated load.
 - 3) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 4) Overload Capacity: Capable of supporting 200 percent of the rated load, fully compressed, without deformation or failure.
 - b. Frame:
 - 1) Provide a steel frame designed to connect to threaded hanger rods, and allow a maximum of 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 - c. Elastomeric Element:
 - 1) Provide a molded, oil-resistant rubber or neoprene element.
 - d. Adjustable Vertical Stop:
 - 1) On the lower threaded rod, provide a steel washer with a neoprene washer "up-stop".
 - e. Hanger Rod Cap:
 - 1) To ensure concentricity between the hanger rod and the support spring coil, provide a self-centering hanger rod cap.
- 10. Manufacturers:
 - a. Kinetics Noise Control, www.kineticsnoise.com.
 - b. Mason Industries, www.mason-ind.com.
 - c. Vibration Mountings & Controls, Inc., <https://www.thevmcgroup.com/>.
 - d. Approved equal.

B. Seismic-Restraint Devices:

- 1. Channel Support Systems:
 - a. Provide a shop- or field-fabricated support assembly complying with the requirements specified in MFMA-4, and fabricated from slotted steel channels.
 - 1) Provide accessories for attaching the channel support system to the braced component at one end, and to the building structure at the other end.



- 2) Provide the matching components with a corrosion-resistant coating.
 - 3) Provide a channel support system rated for the forces in tension, compression, and torsion as specified.
2. Restraint Cables:
 - a. Provide stainless steel cables complying with the requirements specified in ASTM A 492, and having end connections consisting of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service.
 - b. For engaging the cable, provide a minimum of 2 clamping bolts.
3. Hanger Rod Stiffeners:
 - a. Provide a reinforcing steel angle clamped to the hanger rod.
4. Bushings for Floor-Mounted Equipment Anchor Bolts:
 - a. Provide neoprene bushings matched to the type and size of the anchor bolts and studs, and designed for rigid equipment mountings.
5. Resilient Isolation Washers and Bushings:
 - a. Provide one-piece, molded, oil- and water-resistant neoprene washers and bushings with a flat washer face.
6. Anchor Bolts:
 - a. Provide drilled-in and stud-wedge or female-wedge type anchor bolts having the strength required for the anchor when tested according to the requirements specified in ASTM E 488.
 - 1) For interior applications, provide zinc-coated steel anchor bolts.
 - 2) For exterior applications, provide stainless steel anchor bolts.
 - b. Minimum Anchor Bolt Length: 8 times the anchor bolt diameter.
7. Manufacturers:
 - a. B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
 - b. Hilti, Inc.; www.hilti.com.
 - c. Kinetics Noise Control, www.kineticsnoise.com.
 - d. Mason Industries, www.mason-ind.com.
 - e. Unistrut Corp.; Tyco International, Ltd.; www.unistrut.com.
 - f. Approved equal.

2.06 ACCESSORIES

- A. Flexible Piping Connections:
 1. Provide flexible connections for piping complying with requirements specified in Section 15140, Domestic Water Piping.

2.07 SOURCE QUALITY CONTROL

- A. Coordination of Other Tests and Inspections:



1. Notify the code-required Approved Agency responsible for performing special inspections when sound, vibration, and seismic controls for this Contract are being fabricated and/or tested.
2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Inspect the locations intended to receive sound, vibration, and seismic controls for deficiencies which would prevent proper execution of the work.
- B. Evaluation and Assessment:
 1. Do not proceed with sound, vibration, and seismic control installation until deficiencies discovered by the inspection are corrected to the satisfaction of the Program/Project Manager.

3.02 PREPARATION

- A. Surface Preparation:
 1. Pre-position anchors, anchor rods, and other embedded items in advance of new concrete pours whenever possible.

3.03 INSTALLATION

- A. Install seismic-restraint devices using methods approved by an evaluation service member of an agency acceptable to the Authorities Having Jurisdiction (AHJ).
 1. Submit the methods for installing each seismic-restraint device or component approved by an acceptable agency to the Program/Project Manager for information.
- B. Attachment to the Structure:
 1. If specific attachment is not indicated in the Contract Documents, anchor the bracing to the structure at the flanges of beams, at upper truss chords of bar joists, or at concrete members.
- C. Equipment Restraints:
 1. Where the clearance between an anchor and the adjacent surface exceeds 0.125 inch (3.2mm), provide resilient bolt isolation washers on the equipment anchor bolts.



D. Piping Restraints:

1. Provide piping restraints in accordance with the requirements specified in MSS SP-127.
2. Space lateral supports a maximum of 40 feet apart on center, and space longitudinal supports a maximum of 80 feet apart on center.
3. Brace each change of direction longer than 12 feet.
4. Multiple Pipe Supports:
 - a. Secure pipes to trapeze members with clamps approved for the application by an agency acceptable to the Authorities Having Jurisdiction (AHJ).

E. Hanger Rod Stiffeners:

1. Provide hanger rod stiffeners at locations indicated or scheduled on the Contract Drawings to receive them, and where required to prevent buckling of the hanger rods due to seismic forces.

F. Restraint Cables:

1. Install cables so they do not bend across the edges of adjacent equipment or the building structure.

G. Anchor Bolts:

1. Drilled-in Anchors:
 - a. Do not damage existing reinforcing or embedded items during coring or drilling.
 - 1) Prior to drilling holes for drilled-in anchors, locate the position of reinforcing steel and other embedded items.
 - 2) Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 3) Notify the Program/Project Manager if reinforcing steel or other embedded items are encountered during drilling.
 - b. Do not drill holes in concrete or masonry until the concrete, mortar, or grout has achieved its full design strength.
2. Wedge Anchors:
 - a. Provide heavy-duty sleeve anchors with the sleeve fully engaged in the structural element to which anchor is to be fastened.
 - b. Protect wedge anchor threads from damage during anchor installation.
3. Torque anchors to the manufacturer's recommended torque, using a torque wrench.
4. Provide zinc-coated steel anchors for interior applications, and stainless-steel anchors for exterior applications.



5. For floor-mounted equipment, provide bushing assemblies for the anchor bolts arranged to provide resilient media between the anchor bolt and the mounting hole in the concrete base.

H. Special Techniques:

1. Accommodating Differential Seismic Motion:
 - a. Where piping crosses seismic joints, where adjacent sections or branches of piping are supported by different structural elements, and where piping equipment connections terminate so the connection to the equipment anchored to a different structural element than the one supporting the approaching piping, provide flexible connections in the piping.
2. Roof Curbs, Equipment Supports, and Roof Penetrations:
 - a. For the installation of roof curbs, equipment supports, and roof penetrations, comply with requirements specified in Section 07720, Roof Accessories.

3.04 REPAIR/RESTORATION

- A. Remove malfunctioning units, and replace them with new units.
1. Retest the new units as specified in Article 3.06.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
1. During the period when sound, vibration, and seismic controls are being erected, the Testing and Inspection Agency and the code-required Approved Agency must perform testing and inspections.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing and inspection personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Cooperate with the Testing and Inspection Agency and code-required Approved Agency to facilitate their testing and inspections.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Load and Deflection Test:
 - a. Test Procedure:
 - 1) Installed anchors and fasteners selected by Program/Project Manager will be tested.



- a) At least 4 of each type and size of anchor or fastener provided will be tested.
 - b) Unless post-connection testing has been approved, schedule the tests with the Program/Project Manager before connecting the anchorage device to the restrained component and at least 7 days prior to the testing.
 - 2) Verify that the test equipment has recently been calibrated by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ).
 - 3) Furnish temporary load-spreading members.
 - 4) Obtain the Program/Project Manager's approval before transmitting test loads to the structure under test.
 - 5) Apply 90 percent of the rated proof load of the device to the device.
 - 6) Measure the isolator restraint clearance.
 - 7) Measure the isolator deflection.
 - 8) Record the results in Load and Deflection Test Reports, and submit the test reports to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Tested devices that are within the specified parameters are acceptable.
- B. Non-Conforming Work
1. If a device fails the testing, modify all installations of the same type, and retest that type of device until satisfactory results are achieved.

3.06 ADJUSTING

- A. After the piping system is at its operating weight, adjust the isolators.
- B. After equipment installation is complete, adjust the limit stops so they are out of contact during normal operation.
 1. Adjust limit stops on restrained spring isolators to mount equipment at its normal operating height.
- C. Adjust the active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within the normal mode of operation.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First Edition





SECTION 15071

VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Restraining braces and cables.

1.02 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 1.5.
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 75 percent.
 - 4. Design Spectral Response Acceleration at 1-Second Period: 50 percent.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Vibration Isolators:
 - a) Vibration isolation pads.
 - b) Vibration isolation mounts.
 - c) Vibration isolation restrained mounts.
 - d) Spring isolators.
 - e) Restrained spring isolators.



- f) Housed spring mounts.
 - g) Elastomeric hangers.
 - h) Spring hangers.
 - i) Spring hangers with vertical-limit stops.
 - j) Pipe riser resilient support.
 - k) Resilient pipe guides.
 - 2) Seismic-Restraint Devices:
 - a) Channel support systems.
 - b) Restraint cables.
 - c) Hanger rod stiffeners.
 - d) Bushings for floor-mounted equipment anchor bolts.
 - e) Resilient isolation washers and bushings.
 - f) Anchor bolts.
 - b. Certificates:
 - 1) Welding Certificates
 - c. Delegated Design Submittals:
 - 1) For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - d. Qualification Statements:
 - 1) Professional Engineer's qualifications.
- B. Informational Submittals:
- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Field Quality-Control Test Reports.

1.04 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.



PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Vibration Mountings & Controls, Inc.
- D. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- E. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- F. Restrained Mounts: All-directional mountings with seismic.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- G. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.



2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- H. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- I. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.
- J. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- K. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.



2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- L. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- M. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- N. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements



2.02 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control.
 - 4. Mason Industries.
 - 5. Unistrut; Tyco International, Ltd
- D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- E. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- F. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- G. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Expansion-type anchor bolts are not permitted by SEI/ASCE 7 for nonisolated equipment in excess of 10 hp (7.46 kW).



- K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.
- C. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.02 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 7 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2mm).
 - 2. Install seismic-restraint devices using methods approved by [an evaluation service member of an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.



- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.03 ACCOMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
 - 1. Comply with requirements in Section 15140, Domestic Water Piping, for piping flexible connections.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.



2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.06 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. Supported or Suspended Equipment steel:
 1. HVAC Equipment Location: See Contract Drawings.
 - a. Pads:
 - 1) Materials: Neoprene.
 - 2) Thickness: 1 inch.
 - b. Isolator Type: Restrained Spring Isolators.
 - 1) Minimum Deflection: 1.0 inches.
 - 2) Component Importance Factor: 1.5.
 - 3) Component Response Modification Factor: 1.5.
 - 4) Component Amplification Factor: 1.0.
 2. Plumbing Equipment Location: See Contract Drawings.
 - a. Pads:
 - 1) Materials: Neoprene.
 - 2) Thickness: 1 inch.
 - b. Isolator Type: Restrained Spring Isolators.



- 1) Minimum Deflection: 1.0 inches.
- 2) Component Importance Factor: 1.5.
- 3) Component Response Modification Factor: 1.5.
- 4) Component Amplification Factor: 1.0.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/217	N/A	All	First edition.



SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for identifying mechanical systems and equipment with the following labels:
 - a. Equipment labels.
 - b. Warning signs and labels.
 - c. Pipe labels.
 - d. Duct labels.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Mechanical equipment labels.
 - 2) Warning signs and labels.
 - 3) Pipe labels.
 - 4) Duct labels.
 - b. Special Procedure Submittals:
 - 1) Mechanical Equipment Label Schedule.



PART 2 PRODUCTS

2.01 MECHANICAL IDENTIFICATION SYSTEMS

A. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

B. Performance:

1. Equipment Labels:

a. Plastic Labels for Equipment:

- 1) Provide plastic labels for equipment capable of withstanding temperatures up to 160 degrees Fahrenheit.

2. Warning Signs and Labels:

- a. Provide warning signs and labels capable of withstanding temperatures up to 160 degrees Fahrenheit.

3. Duct Labels:

- a. Provide duct labels capable of withstanding temperatures up to 160 degrees Fahrenheit.

4. Pipe Labels:

- a. Provide pipe labels and plastic tapes for bare pipes capable of withstanding temperatures up to 125 degrees Fahrenheit (52 degrees Celsius).
 - 1) Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 degrees Fahrenheit (52 degrees Celsius) or higher.

C. Design Criteria:

1. Mechanical Equipment Labels:

a. Label Content:

- 1) Provide equipment labels that include the mechanical equipment's Contract Drawing designation or unique equipment number, the Contract Drawing numbers where the equipment is indicated (plans, details, and schedules), and the Specification Section number and title where the equipment is specified.

b. Label Size:



- 1) Vary the length and width of metal equipment labels to accommodate the required label content, but do not provide metal equipment labels less than 2-1/2 inches by 3/4 inches in size.
- c. Letter Sizes:
 - 1) For viewing distances less than 24 inches, provide letters for the name of the units that are at least 1/4 inch high.
 - 2) For viewing distances between 24 inches and 72 inches, provide letters for the name of the units that are at least 1/2 inch high.
 - 3) For viewing distances greater than 72 inches, provide lettering proportionately larger than the lettering specified for the lesser viewing distances.
 - 4) Provide secondary lettering that is two-thirds to three-fourths the size of lettering for the name of the units.
- d. Label Colors:
 - 1) Provide equipment labels having the following color scheme:
 - a) Letter Color: Black.
 - b) Background Color: White.
- e. Mechanical Equipment Label Schedule:
 - 1) Prepare a Mechanical Equipment Label Schedule that includes each item of equipment to be labeled; printed on 8-1/2-by-11-inch bond paper.
 - 2) In the Mechanical Equipment Label Schedule, tabulate the equipment identification numbers, and identify the Contract Drawing numbers where the equipment is indicated (plans, details, and schedules), and the Specification Section number and title where the equipment is specified.
 - 3) Submit the Mechanical Equipment Label Schedule to the Program/Project manager for approval.
2. Warning Signs and Labels:
 - a. Label Content:
 - 1) Provide caution and warning information, and emergency notification instructions, on the warning signs and labels.
 - b. Label Size:
 - 1) Vary the length and width of metal equipment labels to accommodate the required label content, but do not provide metal equipment labels less than 2-1/2 inches by 3/4 inches in size.
 - c. Letter Sizes:
 - 1) For viewing distances less than 24 inches, provide letters for the name of the units that are at least 1/4 inch high.



- 2) For viewing distances between 24 inches and 72 inches, provide letters for the name of the units that are at least 1/2 inch high.
- 3) For viewing distances greater than 72 inches, provide lettering proportionately larger than the lettering specified for the lesser viewing distances.
- 4) Provide secondary lettering that is two-thirds to three-fourths the size of lettering for the name of the units.
- d. Sign and Label Colors:
 - 1) Provide warning signs and labels having the following color scheme:
 - a) Letter Color: Black.
 - b) Background Color: White.
3. Pipe Labels:
 - a. Provide preprinted, color-coded, manufactured pipe labels having lettering indicating the pipe service and showing the flow direction.
 - b. Label Content:
 - 1) Provide pipe labels that identify the pipe service using same designations or abbreviations as used on the Contract Drawings, and indicate the pipe size.
 - 2) Flow-Direction Arrows
 - a) Include either an arrow that is integral with the piping system service label and indicating the correct direction of flow in the pipe, or a separate flow arrow unit on each pipe to indicate the correct flow direction.
 - c. Letter Sizes:
 - 1) Provide letters for the labels' legends that are at least 1-1/2 inch high.
 - d. Label Colors:
 - 1) Provide pipe labels having the color schemes scheduled in Table 15075-1.

Table 15075-1 Pipe Label Color Schedule		
Pipe Contents	Background Color	Letter Color
Refrigerant	Blue	White
Domestic water	White	Yellow



Table 15075-1 Pipe Label Color Schedule		
Pipe Contents	Background Color	Letter Color
Sanitary waste and storm drainage	White	Red

4. Duct Labels:

a. Label Content:

- 1) Provide duct labels that identify the duct service using same designations or abbreviations as used on the Contract Drawings, and indicate the duct size.

b. Label Size:

- 1) Vary the length and width of metal equipment labels to accommodate the required label content, but do not provide metal equipment labels less than 2-1/2 inches by 3/4 inches in size.

c. Letter Sizes:

- 1) Provide letters for the labels' legends that are at least 1-1/2 inch high.
- 2) Flow-Direction Arrows
 - a) Include either an arrow that is integral with the piping system service label and indicating the correct direction of flow in the pipe, or a separate flow arrow unit on each pipe to indicate the correct flow direction.

d. Colors:

- 1) Provide duct labels having the following color scheme:
 - a) Letter Color: Black.
 - b) Background Color: White.
- 2) Provide air ducts having the color scheme scheduled in Table 15075-2.

Table 15075-2 Air Duct Label Color Schedule	
Duct Function	Duct Label Color
Cold-air supply ducts	Blue
Hot-air supply ducts	Yellow
Exhaust- air, outside-	Green



Table 15075-2 Air Duct Label Color Schedule	
Duct Function	Duct Label Color
air, relief- air, return- air, and mixed-air ducts	

5. Product Data:

- a. Submit manufacturers Product Data for each type of mechanical identification product proposed for the Work of this Section to the Program/Project Manager for approval.

D. Materials

1. Equipment Labels:

a. Metal Equipment Labels:

1) Material and Thickness:

- a) Provide brass equipment labels, a minimum of 0.032 inch thick, and having predrilled or stamped holes to accommodate attachment hardware.

2) Fasteners:

- a) Provide stainless-steel rivets or self-tapping screws.

3) Adhesive:

- a) Provide contact-type permanent adhesive, compatible with both the label and with the substrate.

b. Plastic Equipment Labels:

1) Material and Thickness:

- a) Provide 1/8 inch thick, multilayer, multicolor, plastic labels suitable for mechanical engraving, and having predrilled holes to accommodate attachment hardware.

2) Fasteners:

- a) Provide stainless-steel rivets or self-tapping screws.

3) Adhesive:

- a) Provide contact-type permanent adhesive, compatible with both the label and with the substrate.

2. Warning Signs and Labels:

a. Material and Thickness:

- 1) Provide 1/8 inch thick, multilayer, multicolor, plastic labels suitable for mechanical engraving, and having predrilled holes to accommodate attachment hardware.

b. Fasteners:



- 1) Provide stainless-steel rivets or self-tapping screws.
- c. Adhesive:
 - 1) Provide contact-type permanent adhesive, compatible with both the label and with the substrate.
3. Pipe Labels:
 - a. Pretensioned Pipe Labels:
 - 1) Provide semirigid plastic pipe labels precoiled and formed to cover the full circumference of the pipe, and capable of being attached to the pipe without fasteners or adhesive.
 - b. Self-Adhesive Pipe Labels:
 - 1) Provide printed plastic pipe labels having a contact-type, permanent-adhesive backing.
4. Duct Labels:
 - a. Material and Thickness:
 - 1) Provide 1/8 inch thick, multilayer, multicolor, plastic labels suitable for mechanical engraving, and having predrilled holes to accommodate attachment hardware.
 - b. Fasteners:
 - 1) Provide stainless-steel rivets or self-tapping screws.
 - c. Adhesive:
 - 1) Provide contact-type permanent adhesive, compatible with both the label and with the substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify the identity of each item before installing identification products.

3.02 PREPARATION

- A. Surface Preparation:
 1. Clean piping and equipment surfaces of substances that could impair the bond of the identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.03 INSTALLATION

- A. Equipment Labels:



1. Install or permanently fasten equipment labels on each major item of mechanical equipment.
2. Locate equipment labels where they are visible and accessible.

B. Pipe Labels:

1. Provide pipe labels as follows where piping is exposed or above accessible ceilings in finished spaces; on piping in machine rooms; on piping in accessible maintenance spaces such as shafts, tunnels, and plenums; and on exterior piping in exposed locations:
 - a. Provide pipe labels near each valve and control device.
 - b. Provide pipe labels near each branch connection, excluding short takeoffs for fixtures and terminal units.
 - 1) Where the flow pattern is not obvious, mark each pipe at the branch.
 - c. Provide pipe labels near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - d. Provide pipe labels at access doors, manholes, and similar access points that permit a view of concealed piping.
 - e. Provide pipe labels near major equipment items, and at other points of origination and termination.
 - f. At intervals along each pipe run, provide pipe labels spaced a maximum of 50 feet apart.
 - 1) In areas of congested piping and equipment, reduce the maximum interval between the pipe labels to 25 feet.
 - g. Provide pipe labels on piping above removable acoustical ceilings.
 - 1) Omit the intermediately spaced labels.

C. Duct Labels:

1. Provide duct labels located near points where the ducts enter into concealed spaces, and at maximum intervals of 50 feet in each space where the ducts are exposed or concealed by a removable ceiling system.

3.04 MAINTENANCE

A. Operation and Maintenance Data:

1. Include the Equipment Label Schedule with the operation and maintenance data furnished in the Operations and Maintenance manuals provided under other Sections.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15076

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 SUBMITTAL

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Equipment Labels
 - a) Metal Labels for Equipment
 - b) Plastic Labels for Equipment
 - c) Equipment Label Schedule
 - 2) Warning Signs and Labels
 - 3) Pipe Labels

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:



1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: White.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.



- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.



3.03 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Low-Pressure and Medium-Pressure Compressed-Air Piping:
 - a. Background Color: White.
 - b. Letter Color: Blue.
2. Domestic Water Piping:
 - a. Background Color: White.
 - b. Letter Color: Yellow.
3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: White.
 - b. Letter Color: Red.

Per RFI 0974,
Piping Labels to
follow ANSI Z 535.1

RFI
0974

Piping Labels
Clarification

END OF SECTION

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0	10/06/2017	N/A	All	First edition.



SECTION 15077

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.

1.02 SUBMITTAL

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Equipment Labels
 - a) Metal Labels for Equipment
 - b) Plastic Labels for Equipment
 - c) Equipment Label Schedule
 - 2) Warning Signs and Labels
 - 3) Pipe Labels
 - 4) Duct Labels

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.



- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and



proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.04 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.



- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.



5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- B. Pipe Label Color Schedule:
1. Heating Water Piping:
 2. Background Color: Red.
 3. Letter Color: White.
 4. Refrigerant Piping:
 5. Background Color: Blue.
 6. Letter Color: White.

3.04 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

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0	10/06/2017	N/A	All	First edition.





SECTION 15080

MECHANICAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following mechanical insulation materials and accessories:
 - a. Insulation Materials:
 - 1) Mineral-fiber.
 - 2) Polyolefin.
 - 3) Cellular glass.
 - 4) Flexible elastomeric.
 - b. Adhesives.
 - c. Mastics.
 - d. Sealants.
 - e. Field-applied jackets.
 - f. Tapes.
 - g. Securements.
 - h. Corner angles.
- B. Products Supplied But Not Installed Under This Section:
 - 1. Factory-applied jackets.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 07850 - Through Penetration Firestopping Systems.
 - 5. Section 09912 - Painting.
 - 6. Section 09960 - High-Performance Coatings.
 - 7. Section 15060 - Hangers and Supports.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ASJ: All-service vapor retarder jacket.
 - 2. CFC: Chlorofluorocarbons, a type of refrigerant chemical.
 - 3. FSK: Foil-scrim-kraft facing.
 - 4. HCFC: Hydrochlorofluorocarbons, a type of refrigerant chemical.
 - 5. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 6. PVC: Polyvinyl-chloride.



7. SCAQMA: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside and San Bernardino counties.
8. UV: Ultraviolet.
9. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressure under normal conditions to significantly vaporize and enter the atmosphere.

B. Reference Standards:

1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
 - a. ASTM A 167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - c. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - d. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - e. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - f. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - g. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation.
 - h. ASTM C 871 - Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
 - i. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - j. ASTM C 1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - k. ASTM C 1427 - Standard Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form.
 - l. ASTM D 1644 - Standard Test Methods for Nonvolatile Content of Varnishes.
 - m. ASTM D 1784 - Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.



- n. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- o. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
 - b. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
- 6. South Coast Air Quality Management District (SCAQMA):
 - a. SCAQMA Rule 1168 – Adhesive and Sealant Applications.
- 7. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
 - b. United States Department of Defense (DOD):
 - 1) Military Specifications (MIL):
 - a) MIL-A-24179 - Adhesive, Flexible Unicellular - Plastic Thermal Insulation.
 - b) MIL-A-3316 - Adhesives, Fire-Resistant, Thermal Insulation.
 - c) MIL-C-20079 – Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass.
 - d) MIL-PRF-19565 - Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the mechanical insulation with the size and location of the supports, hangers, and insulation shields specified in Section 15060, Hangers and Supports.
 - 2. Coordinate the clearance requirements for applying piping insulation with the piping and ductwork installers.
 - a. Before preparing piping and ductwork Shop Drawings, establish and maintain the clearance requirements for installing insulation and field-applied jackets and finishes, and for allowing space for maintenance.
 - 3. Coordinate the clearance requirements for applying equipment insulation with the equipment installers.
 - 4. Coordinate the installation of mechanical insulation with the installation and testing of heat tracing systems.
 - a. Comply with the requirements for the heat-tracing systems that apply to insulation.



B. Sequencing:

1. Apply insulation after pressure testing the mechanical systems; and, where applicable, after installing and testing heat tracing.
 - a. Insulation may be applied on segments of the mechanical systems that have satisfactory pressure test results.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Mineral-fiber insulation.
 - 2) Polyolefin insulation.
 - 3) Cellular glass pipe insulation.
 - 4) Flexible elastomeric insulation.
 - 5) Mineral-fiber insulating cement.
 - 6) Adhesives.
 - 7) Mastics.
 - 8) Sealants.
 - 9) Factory-applied jackets.
 - 10) Field-applied cloths.
 - 11) Field-applied jackets and fitting covers.
 - 12) Tapes.
 - 13) Securements.
 - 14) Corner angles.
 - b. Qualification Statements:
 - 1) Mechanical insulation installer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Fire-Test-Response Test Reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:



- a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 - 1. Mechanical Insulation Installer's Qualifications:
 - a. Employ skilled mechanics who have successfully completed an apprenticeship program, or another craft training program, certified by the Department of Labor, Bureau of Apprenticeship and Training to install the mechanical insulation.
 - b. Submit the mechanical insulation installer's qualifications to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Adhesives and Sealants Submittal:
 - a. For the adhesives used with the mechanical insulation, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, signed by the product manufacturer, to the Program/Project Manager for information.
 - 1) Certify compliance with SCAQMA Rule 1168.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Furnish the insulation material in containers marked by the manufacturer with the appropriate ASTM International (ASTM) standard designation, type, and grade, and the maximum use temperature.
- B. Storage and Handling Requirements:
 - 1. Keep insulation materials dry during application and finishing.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MECHANICAL INSULATION COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed, if manufacturers are listed.
 - 2. Substitution Limitations:



- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

b. Fire-Test-Response Characteristics:

- 1) For insulation materials to be installed where fire-performance characteristics are required, provide insulation materials having surface-burning characteristics as follows as determined when an independent Testing and Inspecting Agency acceptable to the Authorities Having Jurisdiction tests identical products in accordance with the requirements specified in ASTM E 84:
 - a) For Insulation Installed Indoors:
 - (1) Flame-Spread Index: 25 or less.
 - (2) Smoke-Developed Index: 50 or less.
 - b) For Insulation Installed Outdoors:
 - (1) Flame-Spread Index: 75 or less.
 - (2) Smoke-Developed Index: 150 or less.
- 2) Factory-label the insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with the appropriate markings of the applicable Testing and Inspecting Agency.
- 3) Submit verification Fire-Test-Response Test Reports to the Program/Project Manager for information.

2. Sustainability Requirements:

a. Volatile Organic Compounds (VOC) Content of Interior Adhesives and Sealants:

- 1) Provide interior adhesives, sealants, and primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Adhesives Primer for Plastic: Not more than 550 grams per Liter less water.
 - b) Fiberglass: Not more than 80 grams per Liter less water.
 - c) Plastic Cement Welding: Not more than 250 grams per Liter less water.
 - d) Plastic Foams: Not more than 50 grams per Liter less water.
 - e) Porous Material (Except Wood): Not more than 50 grams per Liter less water.



f) PVC Welding: Not more than 510 grams per Liter less water.

C. Design Criteria:

1. Hazardous Materials:

- a. Do not provide mechanical insulation products containing detectable asbestos, lead, mercury, or mercury compounds.
- b. Do not provide foam insulation materials manufactured using CFC or HCFC blowing agents during the manufacturing process.

2. Product Data:

- a. For each type of insulation, adhesive, and sealant specified, submit Product Data to the Program/Project Manager for approval.
 - 1) Include the thermal conductivity, thickness, and factory-applied or field-applied jackets, if any.

D. Materials:

1. Flexible Elastomeric Insulation:

- a. For plumbing applications, provide closed-cell, sponge- rubber or expanded-rubber materials complying with the requirements specified in ASTM C 534 as follows:
 - 1) For tubular materials, provide insulation complying with the requirements specified for Type I insulation.
 - 2) For sheet materials, provide insulation complying with the requirements specified for Type II insulation.

2. Mineral-Fiber Insulating Cement:

- a. For plumbing applications, provide insulating cement complying with the requirements specified in ASTM C 195.
- b. Manufacturers:
 - 1) Insulco, Division of MFS, Inc.; Triple I.
 - 2) P. K. Insulation Manufacturing Co., Inc.; Super-Stik.
 - 3) Approved equal.

3. Adhesives:

- a. Provide adhesives compatible with insulation materials, jackets, and substrates; and, unless otherwise indicated, suitable for bonding the insulation to itself and to the surfaces to be insulated.
- b. Cellular-Glass Adhesive:
 - 1) For plumbing applications, provide solvent-based resin adhesive having a service temperature range of minus 75 degrees Fahrenheit to plus 300 degrees Fahrenheit.
- c. Flexible Elastomeric and Polyolefin Adhesive:
 - 1) For plumbing applications, provide flexible elastomeric and polyolefin adhesives complying with the requirements for Type II, Class 1 adhesives specified in MIL-A-24179.
- d. Jacket Adhesive:
 - 1) For plumbing applications when bonding insulation jacket lap seams and joints, provide all-service jacket (ASJ) adhesive or foil-



- scrim-kraft (FSK) jacket adhesive complying with the requirements for Class 2, Grade A adhesives specified in MIL-A-3316.
- 2) For PVC jackets, provide adhesive that is compatible with the PVC jacket.
- e. Mineral-Fiber Adhesive:
 - 1) For HVAC applications, provide mineral-fiber adhesive complying with the requirements for Class 2, Grade A adhesives specified in MIL-A-3316.
- 4. Mastics:
 - a. Provide mastics that are compatible with the insulation materials, jackets, and substrates; and that comply with the requirements for Type II mastic specified in MIL-C-19565.
 - b. Vapor-Barrier Mastic:
 - 1) Provide water based vapor-barrier mastic suitable for indoor and outdoor use on below ambient services.
 - 2) For HVAC applications, provide white vapor-barrier mastic having the following physical properties:
 - a) Water Vapor Permeance:
 - (1) Provide mastic having a water vapor permeance of 0.013 perms at a dry film thickness of 43 mils when tested in accordance with the Procedure B specified in ASTM E 96/E 96M.
 - b) Service Temperature Range:
 - (1) Provide mastic having a service temperature range from minus 20 degrees Fahrenheit to plus 180 degrees Fahrenheit.
 - c) Solids Content:
 - (1) Provide mastic having a solids content of 59 percent by volume and 71 percent by weight when determined using the methods specified in ASTM D 1644.
- 5. Sealants:
 - a. Joint Sealants:
 - 1) Provide joint sealant materials that are compatible with the insulation materials, jackets, and substrates.
 - 2) For HVAC applications, provide white or gray permanently flexible, elastomeric sealant having a service temperature range from minus 100 degrees Fahrenheit to plus 300 degrees Fahrenheit.
 - 3) For plumbing applications, provide fire-resistant and water-resistant, flexible, elastomeric sealant having a service temperature range from minus 40 degrees Fahrenheit to plus 250 degrees Fahrenheit.
 - b. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:



- 1) Provide white fire-resistant and water-resistant, flexible, elastomeric sealants that are compatible with the insulation materials, jackets, and substrates.
 - 2) Provide sealants having a service temperature range from minus 40 degrees Fahrenheit to plus 250 degrees Fahrenheit.
6. Factory-Applied Jackets:
 - a. The insulation system schedules indicate factory-applied jackets for various applications.
 - b. Where factory-applied jackets are indicated for various applications in the insulation system schedules, provide jackets complying with the following requirements for the appropriate jacket:
 - 1) All-Service Jackets (ASJ):
 - a) Provide factory-applied white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing that complies with the requirements for Type I vapor retarders specified in ASTM C 1136.
 - 2) Self-Sealing All-Service Jackets (ASJ):
 - a) Provide factory-applied all-service jackets (ASJ) having self-sealing, pressure –sensitive, acrylic-based adhesive covered by a removable protective strip, similar to Owens Corning’s ASJ-SSL® pipe insulation, and that comply with the requirements for Type I vapor retarders specified in ASTM C 1136.
 - 3) Foil-Scrim-Kraft (FSK) Faced Jacket:
 - a) Provide factory-applied aluminum-foil, fiberglass-reinforced scrim jackets with kraft-paper backing that comply with the requirements for Type II vapor retarders specified in ASTM C 1136.
 - 4) Vinyl Jacket:
 - a) Provide factory-applied white vinyl jackets having a permeance of 1.3 perms when tested in accordance with the requirements of Procedure A specified in ASTM E 96/E 96M, and complying with the requirements specified in NFPA 90A and NFPA 90B.
7. Tapes:
 - a. All-Service Jacket (ASJ) Tape:
 - 1) Provide white vapor-retarder tape complying with the requirements specified in ASTM C 1136, matching the factory-applied jacket, having acrylic adhesive, and having the following features:
 - a) Width: 3 inches.
 - b) Thickness: 11.5 mils.
 - c) Adhesion: 90 ounces force per inch of width.
 - d) Elongation: 2 percent.
 - e) Tensile Strength: 40 pounds force per inch of width.



- b. Polyvinyl-Chloride (PVC) Tape:
 - 1) Provide white vapor-retarder tape matching the field-applied polyvinyl-chloride (PVC) jackets, having acrylic adhesive, suitable for indoor and outdoor applications, and having the following features:
 - a) Width: 2 inches.
 - b) Thickness: 6 mils.
 - c) Adhesion: 64 ounces force per inch of width.
 - d) Elongation: 500 percent
 - e) Tensile Strength: 18 pounds force per inch of width.
 - c. Foil-Scrim-Kraft (FSK) Tape:
 - 1) For HVAC applications only, provide foil-faced, vapor retarder tape complying with the requirements specified in ASTM C 1136, matching the factory-applied jacket, having acrylic adhesive, and having the following features:
 - a) Width: 3 inches.
 - b) Thickness: 11.5 mils.
 - c) Adhesion: 90 ounces force per inch of width.
 - d) Elongation: 2 percent.
 - e) Tensile Strength: 40 pounds force per inch of width.
 - d. Aluminum-Foil Tape:
 - 1) For plumbing applications only, provide vapor-retarder tape having acrylic adhesive.
8. Securements:
- a. Bands:
 - 1) Stainless Steel:
 - a) Provide 0.015-inch thick stainless steel bands complying with the requirements for Type 304 stainless steel specified in ASTM A 167 or ASTM A 240/A 240M, that are 1/2 inch wide, and that have a wing or closed seal.
 - (1) For HVAC applications only, Type 316 stainless steel bands may be provided.
 - 2) Aluminum:
 - a) Provide 0.020-inch thick aluminum Alloy 3003, 3005, 3105, or 5005 bands complying with the requirements for Temper H-14 aluminum specified in ASTM B 209 or ASTM B 209M, that are 1/2 inch wide, and that have a wing or closed seal.
 - 3) Springs:
 - a) For HVAC applications only, provide a twin spring set constructed of stainless steel with flat and slotted ends designed to accept metal bands.
 - (1) Provide springs sized by the manufacturer for the application.
 - b. Insulation Pins and Hangers:
 - 1) Capacitor-Discharge-Weld Pins:



- a) Provide copper- coated or zinc-coated steel pins, fully annealed for capacitor-discharge welding, of a length to suit the depth of the insulation indicated in the insulation schedules appended to the end of this Section, and having a shank diameter as follows:
 - (1) For HVAC applications only, provide a 0.106-inch-diameter shank.
 - (2) For plumbing applications only, provide a 0.135-inch-diameter shank.
- 2) Cupped-Head, Capacitor-Discharge-Weld Pins:
 - a) Provide copper- coated or zinc-coated steel pins, fully annealed for capacitor-discharge welding, of a length to suit the depth of the insulation indicated in the insulation schedules appended to the end of this Section, having an integral 1-1/2-inch galvanized carbon-steel washer, and having a shank diameter as follows:
 - (1) For HVAC applications only, provide a 0.106-inch-diameter shank.
 - (2) For plumbing applications only, provide a 0.135-inch-diameter shank.
 - 3) Insulation-Retaining Washers:
 - a) Provide self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, having a beveled edge, and sized as required to hold the insulation securely in place, but not less than 1-1/2 inches in diameter.
 - b) For HVAC applications in exposed locations only, protect the ends with capped self-locking washers incorporating a spring steel insert to ensure the permanent retention of the cap.
- c. Staples:
 - 1) Provide stainless steel or Monel outward-clinching insulation staples that are nominally 3/4 inch wide.
- d. Wire:
 - 1) Provide 080-inch nickel-copper alloy wire, or soft annealed stainless steel wire.
- 9. Corner Angles:
 - a. Aluminum Corner Angles:
 - 1) For HVAC applications only, provide aluminum Alloy 3003, 3005, 3105, or 5005 corner angles complying with the requirements for Temper H-14 material specified in ASTM B 209 or ASTM B 209M.

2.02 ACCESSORIES

- A. Firestopping and Fire-Resistive Joint Sealers:
 - 1. Provide firestopping and fire-resistive joint sealers complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that the surfaces to be insulated are clean and dry.
- B. Evaluation and Assessment:
 - 1. Install the insulation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the mechanical insulation.
- B. Surface Preparation:
 - 1. Clean and dry the surfaces to receive insulation.
 - a. Remove materials that will adversely affect the application of the insulation.

3.03 INSTALLATION

- A. General Insulation Installation Requirements:
 - 1. For services above ambient, do not install insulation to the following:
 - a. Vibration-control devices.
 - b. Testing agency labels and stamps.
 - c. Nameplates and data plates.
 - d. Manholes.
 - e. Handholes.
 - f. Cleanouts.
 - 2. Install the insulation materials, forms, vapor barriers or retarders, and jackets required for each item of equipment and pipe system as specified in the insulation system schedules appended to the end of this Section; and install the insulation to the specified thicknesses.
 - a. Cut insulation in a manner that avoids compressing the insulation to more than 75 percent of its nominal thickness.
 - b. Install the insulation materials, accessories, and finishes so their surfaces are smooth, straight, even, and free of voids throughout the length of the equipment and piping, including fittings, valves, and specialties.
 - c. Install insulation with least number of joints practical.
 - d. Install insulation with its longitudinal seams at the top and bottom of horizontal runs.



- 1) To eliminate openings in the insulation that allow passage of air to the surface being insulated, seal longitudinal seams and end joints of flexible elastomeric insulation with the manufacturer's recommended adhesive.
 - e. Install multiple layers of insulation so their longitudinal and end seams are staggered.
 - f. Apply adhesives, mastics, and sealants at the manufacturer's recommended coverage rate, and to their recommended wet and dry film thicknesses.
 - g. Mix insulating cements using clean potable water unless the insulating cements are to be in contact with stainless-steel surfaces.
 - 1) For insulating cements in contact with stainless-steel surfaces, mix insulating cements using demineralized water.
 - h. Complete the installation and concealment of plastic materials as rapidly as possible in each area of construction.
3. Accessories:
 - a. Provide accessories compatible with the insulation materials and suitable for the service.
 - b. Install accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either a wet or dry state.
 - c. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
4. Vapor Barrier:
 - a. Where vapor barrier is indicated, seal the joints, seams, and penetrations in the insulation at the hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1) Install insulation continuously through hangers and around anchor attachments.
 - 2) Extend insulation on anchor legs from the point of attachment to the supported item to the point of attachment to structure.
 - a) Taper the ends at the attachment to the structure, and seal the ends with vapor-barrier mastic.
 - 3) Provide insert materials, and install insulation to tightly join the insert.
 - a) Seal insulation to the insulation inserts with an adhesive or sealing compound recommended by the insulation material's manufacturer.
 - 4) Cover inserts with jacket material matching the adjacent pipe insulation.
 - a) Install shields over the jacket, and arrange the shields to protect the jacket from tears or punctures caused by hangers, supports, or the shield.
5. Factory-Applied Insulation Jackets:
 - a. Install insulation with factory-applied jackets as follows:
 - 1) Draw the jacket tight and smooth.



- 2) Cover circumferential joints with 3-inch-wide strips of the same material as the insulation jacket.
 - a) Secure the strips with adhesive and outward clinching staples spaced 4 inches on center along both edges of strip.
- 3) Overlap the jacket longitudinal seams at least 1-1/2 inches.
 - a) Install insulation with the longitudinal seams at the bottom of the pipe.
 - b) Clean and dry the surface to receive self-sealing laps.
 - c) Staple the laps with outward clinching staples along the edge at 2 inches on center.
 - (1) For below ambient services, apply vapor-barrier mastic over the staples.
- 4) Cover the joints and seams with tape as recommended by the insulation material's manufacturer to maintain vapor seal.
- 5) Where vapor barriers are indicated, apply vapor-barrier mastic on the seams and joints, and at the ends adjacent to pipe flanges and fittings.

B. Penetrations:

1. Roof Penetrations:
 - a. Install insulation at roof penetrations continuously through the roof penetrations.
 - b. Seal the penetrations using flashing sealant.
 - c. For applications requiring only indoor insulation, terminate the insulation above the roof surface, and using joint sealant seal the insulation.
 - d. For applications requiring both indoor and outdoor insulation, install the insulation for the outdoor applications so it is tightly joined to the ends of the indoor insulation.
 - 1) Seal the joint with joint sealant.
 - e. Extend the jacket of outdoor insulation outside the roof flashing at least 2 inches below the top of the roof flashing.
 - 1) Seal the jacket to the roof flashing with flashing sealant.
2. Underground Exterior Wall Penetrations:
 - a. At underground exterior wall penetrations, terminate the insulation flush with the sleeve seal.
 - b. Seal the terminations using flashing sealant.
3. Aboveground Exterior Wall Penetrations:
 - a. At aboveground exterior wall penetrations, install the insulation continuously through the wall penetrations.
 - 1) Seal the penetrations using flashing sealant.
 - b. For applications requiring only indoor insulation, terminate the insulation inside the wall surface, and seal the insulation with joint sealant.



- c. For applications requiring both indoor and outdoor insulation, install insulation for the outdoor applications so it is tightly joined to the ends of the indoor insulation, and seal the joint using joint sealant.
 - d. Extend the jacket of outdoor insulation outside the wall flashing, and overlap the wall flashing at least 2 inches.
 - 1) Seal the jacket to the wall flashing using flashing sealant.
 - 4. Interior Wall and Partition Penetrations:
 - a. Fire-Rated Penetrations:
 - 1) At interior wall and partition penetrations that are fire rated, install the insulation continuously through the penetrations of fire-rated walls and partition.
 - 2) Terminate the insulation at the fire damper sleeves for the fire-rated wall and partition penetrations.
 - 3) Externally insulate the damper sleeves to match the adjacent insulation, and overlap the duct insulation at least 2 inches.
 - 4) Install firestopping and fire-resistive joint sealers in accordance with the requirements specified in Section 07850, Through Penetration Firestopping Systems.
 - b. Penetrations Not Fire Rated:
 - 1) At interior wall and partition penetrations that are not fire rated, install the insulation continuously through the walls and partitions.
 - 5. Floor Penetrations:
 - a. Duct Floor Penetrations:
 - 1) For penetrations through assemblies that are not fire-rated, install the duct insulation continuously through the floor penetrations.
 - 2) For penetrations through fire-rated assemblies, terminate the duct insulation at the fire damper sleeves, and externally insulate the damper sleeve beyond the floor to match the adjacent duct insulation.
 - a) Overlap the damper sleeve and the duct insulation at least 2 inches.
 - b. Pipe Floor Penetrations:
 - 1) Install pipe insulation continuously through floor penetrations.
 - c. Seal the penetrations through fire-rated assemblies.
 - 1) Install firestopping and fire-resistive joint sealers in accordance with the requirements specified in Section 07850, Through Penetration Firestopping Systems.
- C. Pipe Insulation:
 - 1. Insulation on Fittings, Valves, Strainers, Flanges, and Unions:
 - a. Unless otherwise indicated in the Contract Documents, provide insulation over fittings, valves, strainers, flanges, unions, and other specialties maintaining continuous thermal and vapor-retarder integrity.
 - b. Pipe Elbows:



- 1) To insulate plumbing pipe elbows, provide preformed fitting insulation or mitered fittings made from the same material having the same density as the adjacent pipe insulation.
 - a) Butt each piece of insulation tightly against the adjoining piece, and bond them with adhesive.
 - b) Fill joints, seams, voids, and irregular surfaces with insulating cement, and finish the cement to a smooth, hard, and uniform contour even with the adjoining pipe insulation.
- 2) To insulate HVAC pipe elbows, provide mitered sections of pipe insulation.
 - a) Secure the insulation materials, and seal the seams with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- c. Tee Fittings:
 - 1) To insulate plumbing tee fittings, provide preformed fitting insulation or sectional pipe insulation made from the same material having the same thickness as provided for the adjacent pipe insulation.
 - a) Cut sectional pipe insulation to fit.
 - b) Butt each section closely to the next, and hold each in place with tie wire.
 - c) Bond the pieces using adhesive.
 - 2) To insulate HVAC tee fittings, provide mitered sections of pipe insulation.
 - a) Secure the insulation materials, and seal the seams with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- d. Valves:
 - 1) To insulate plumbing valves, provide preformed fitting insulation or sectional pipe insulation made from the same material having the same thickness as provided for the adjacent pipe insulation.
 - a) Overlap adjoining pipe insulation by not less than 2 times the thickness of the pipe insulation, or one pipe diameter, whichever is thicker.
 - b) Insulate up to and including the valve bonnets, and valve stuffing-box studs, bolts, and nuts.
 - c) Fill joints, seams, and irregular surfaces using insulating cement.
 - 2) To insulate HVAC valves and piping specialties, provide preformed covers manufactured from the same material as the pipe insulation.
 - a) If preformed covers are unavailable, provide cut sections of pipe and sheet insulation for valve or specialty body.



- (1) Arrange the insulation to permit access to the valve packing, and to allow valve operation without disturbing the insulation.
 - b) Secure the insulation to the valves and specialties, and the seal seams with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - e. Strainers:
 - 1) To insulate plumbing strainers, provide preformed fitting insulation or sectional pipe insulation made from the same material, density, and thickness as provided for the adjacent pipe insulation.
 - a) Overlap adjoining pipe insulation by not less than 2 times the thickness of the pipe insulation, or one pipe diameter, whichever is thicker.
 - b) Fill joints, seams, and irregular surfaces using insulating cement.
 - c) Insulate strainers so the strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket.
 - (1) Provide a removable reusable insulation cover.
 - (2) For below ambient services, provide a design that maintains the integrity of the vapor barrier.
 - f. Pipe Flanges and Unions:
 - 1) To insulate pipe flanges and unions, provide a section of oversized preformed pipe insulation.
 - 2) Overlap adjoining pipe insulation by not less than 2 times the thickness of the pipe insulation, or one pipe diameter, whichever is thicker.
 - g. Segmented Insulated Surfaces:
 - 1) Cover the segmented insulated surfaces with a layer of finishing cement, and coat the surface with mastic.
 - a) For below ambient services, provide vapor-barrier mastic.
 - b) For above ambient services, provide a breather mastic.
 - 2) Reinforce the mastic with fabric-reinforcing mesh.
 - 3) Trowel the mastic to a smooth and well-shaped contour.
 - 2. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install a fitted polyvinyl-chloride (PVC) cover over elbows, tees, strainers, valves, flanges, and unions.
 - a. Terminate the ends with polyvinyl-chloride (PVC) end caps.
 - b. Tape polyvinyl-chloride (PVC) covers to the adjoining insulation facing using PVC tape.
- D. Instrument Connections:
 - 1. Insulate the instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment.



2. Shape the insulation at these connections by tapering it to and around the connection with insulating cement, and finish the insulation using finishing cement, mastic, and flashing sealant.

E. Field-Applied Jackets:

1. Where glass-cloth jackets are indicated, install the jackets directly over the bare insulation or insulation with factory-applied jackets.
 - a. Draw the jacket smooth and tight to the surface with a 2-inch overlap at the seams and joints.
 - b. Embed the glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 1) Completely encapsulate the insulation in the coating, leaving no exposed insulation.
2. Where foil-scrim-kraft (FSK) jackets are indicated, install the jackets as follows:
 - a. Draw the jacket material smooth and tight.
 - b. Install lap or joint strips of the same material as the jacket.
 - c. Secure the jacket to the insulation with the manufacturer's recommended adhesive.
 - d. Install the jacket with 1-1/2-inch laps at the longitudinal seams and 3-inch-wide joint strips at the end joints.
 - e. Seal openings, punctures, and breaks in the vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
3. Where polyvinyl-chloride (PVC) jackets are indicated, install the jackets with a 1-inch overlap at the longitudinal seams and end joints.
 - a. For horizontal tank and vessel applications, install the jackets with the longitudinal seams along the top and bottom of tanks and vessels.
 - 1) Seal the seams with the manufacturer's recommended adhesive.
 - b. Apply 2 continuous beads of adhesive to the seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, provide the jackets with a 2-inch overlap at the longitudinal seams and end joints
 - a. Overlap and arrange longitudinal seams to shed water.
 - b. Seal the end joints with a weatherproof sealant recommended by the insulation manufacturer.
 - c. Secure the jacket with stainless-steel bands 12 inches on center and at the end joints.

F. Special Techniques:

1. Finishes:
 - a. Finish insulation with the systems at operating conditions.
 - b. Metal Jackets:
 - 1) Do not field paint aluminum or stainless-steel jackets.
 - c. All-Service Jackets (ASJ):
 - 1) Paint the all-service jackets (ASJ) with 2 finish coats over a primer in accordance with the requirements specified in Section 09912,



Painting, Section 09960, High-Performance Coatings, and as follows:

- a) Provide a flat acrylic primer that is compatible with both the jacket material and the finish coat paint, and having a fungicidal agent added to render the jacket fabric mildew proof.
- b) Provide finish coats consisting of an interior, flat, latex-emulsion size.
- d. Flexible Elastomeric Thermal Insulation:
 - 1) After insulation adhesive has fully cured, apply 2 coats of the insulation manufacturer's recommended protective coating.
- e. Color:
 - 1) Provide final colors as selected by the Program/Project Manager.
 - 2) Vary the first and second coats to allow the Program/Project Manager to visually inspect the completed Work.

3.04 REPAIR/RESTORATION

- A. Repair damaged insulation facings by applying the same facing material used for the original installation over the damaged areas.
 - 1. Extend patches at least 4 inches beyond damaged areas.
 - 2. Adhere, staple, and seal patches in a manner similar to installing butt joints.
- B. Repair joint separations and cracking in insulation due to thermal movement.

3.05 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Take steps to ensure that installed mechanical insulation is protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15082

PLUMBING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Mineral-Fiber.
 - b. Polyolefin.
 - 2. Adhesives.
 - 3. Mastics.
 - 4. Sealants.
 - 5. Factory-applied jackets.
 - 6. Field-applied jackets.
 - 7. Tapes.
 - 8. Securements.
- B. Related Sections include the following:
 - 1. Division 15 Section "HVAC Insulation."

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Insulation Materials
 - a) Mineral-Fiber, Preformed Pipe Insulation.
 - b) Polyolefin.
 - 2) Insulating Cements
 - a) Mineral-Fiber Insulating Cement.
 - 3) Adhesives
 - a) Flexible Elastomeric and Polyolefin Adhesive
 - b) Mineral-Fiber Adhesive.
 - c) ASJ Adhesive.
 - d) PVC Jacket Adhesive.
 - 4) Mastics



- a) Vapor-Barrier Mastic.
- 5) Sealants
 - a) Joint Sealants.
 - b) ASJ Flashing Sealants and PVC Jacket Flashing Sealants.
- 6) Factory-Applied Jackets
 - a) ASJ.
- 7) Field-Applied Jackets
 - a) PVC Jacket.
- 8) Tapes
 - a) ASJ Tape.
 - b) PVC Tape.
 - c) Aluminum-Foil Tape.
- 9) Securements
 - a) Bands.
 - (1) Stainless Steel.
 - (2) Aluminum.
 - b) Insulation Pins and Hangers.
 - (1) Capacitor-Discharge-Weld Pins.
 - (2) Cupped-Head, Capacitor-Discharge-Weld Pins.
 - (3) Insulation-Retaining Washers.
 - c) Staples.
 - d) Wire.
- b. Qualification Statements:
 - 1) Installer's qualifications.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. When fire-performance characteristics are important requirements, verify surface-burning characteristics of insulation materials by an independent testing agency and require test report submittals.
- C. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.



1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.



- E. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
 - c. RBX Corporation; Therma-cell.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

2.05 SEALANTS

- A. Joint Sealants:



1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White

2.06 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

2.09 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304.
 2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.



- B. Insulation Pins and Hangers:
 - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
 - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, and length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy soft-annealed, stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.



- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - 4. For below ambient services, apply vapor-barrier mastic over staples.



5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 GENERAL PIPE INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the



thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.06 FINISHES

- A. Equipment and Pipe Insulation with ASJ Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.



1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 2. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.07 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Underground piping.
 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.08 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Roof Drain bodies, Roof Drain leaders, and Overflow Drain bodies:
1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Exposed Sanitary Drains, Domestic Hot and Tempered Water Supply Piping, and Stops for Plumbing Fixtures for People with Disabilities (any fixture on plans identified as "ADA" or "handicap"):
1. All Pipe Sizes: Insulation shall be the following:
 - a. Polyolefin: 3/4 inch thick.

3.09 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.



- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.

END OF SECTION

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SECTION 15083

HVAC INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - 2. Adhesives
 - 3. Mastics.
 - 4. Sealants.
 - 5. Factory-applied jackets.
 - 6. Field-applied jackets.
 - 7. Tapes.
 - 8. Securements.
 - 9. Corner angles.
- B. Related Sections include the following:
 - 1. Division 15 Section "Plumbing Insulation."
 - 2. Division 15 Section "Metal Ducts" for duct liners.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency



acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.



- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 2. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- H. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- I. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
- J. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- K. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- L. PVC Jacket Adhesive: Compatible with PVC jacket.

2.02 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perms at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.



4. Color: White.

2.03 SEALANTS

- A. Joint Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
- B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.

2.04 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.05 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.06 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.



- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.07 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.



4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.

2.08 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy soft-annealed, stainless steel.

2.09 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.



- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209 , Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat-tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.



- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - 4. For below ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.



- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.



- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.05 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.



1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.07 FINISHES

- A. Do not field paint aluminum or stainless-steel jackets.

3.08 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
- B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.



3.09 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round, rectangular, and flat-oval, supply-air duct insulation shall be the following:
 - 1. Cellular Glass Insulation: 1-1/2 inches nominal density.
- B. Concealed, outdoor-air plenum insulation shall be the following:
 - 1. Cellular Glass Insulation: 2 inches nominal density.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- C. Chilled Water Supply and Return, between 40 and 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch thick.

3.12 OUTDOOR, ABOVE GROUND PIPING INSULATION SCHEDULE

- A. Chilled Water Supply and Return, between 40 and 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.

RFI
1876

Stations Outdoor
Refrigerant Piping
Insulation Thickness

Thickness also applies to outdoor above
ground refrigerant piping per RFI 1876

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.



- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed or Exposed:
 - 1. None.
- D. Piping, Concealed:
 - 1. None.
- E. Piping, Exposed:
 - 1. PVC: 30 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed or Exposed:
 - 1. Painted Aluminum, Smooth 0.032 inch thick.
- D. Piping, Concealed or Exposed:
 - 1. Painted Aluminum, Smooth ~~0.032 inch~~ thick.

0.016 inch per RFI

1784 for the stations



Stations Outdoor Pipe
Aluminum Jacket
Thickness

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	08/08/2018	RFI-0310	Edited 3.11, Added 3.12 and 3.14.	Updated for RFI-310.



SECTION 15110

VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of general duty valves and accessories:
 - a. Bronze ball valves.
 - b. Iron ball valves.
 - c. Iron, grooved-end butterfly valves.
 - d. Iron, grooved-end swing-check valves.
 - e. Chain wheels.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 15075 - Mechanical Identification.
 - 7. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene propylene copolymer rubber.
 - 3. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
 - 4. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
 - 5. PTFE: Polytetrafluoroethylene, a synthetic fluoropolymer also known by the DuPont brand name Teflon.
 - 6. SWP: Steam working pressure.
 - 7. TFE: Tetrafluoroethylene, a synthetic fluoropolymer.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):



- a. ANSI/ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- b. ANSI/ASME B16.10 – Face-to-Face and End-to-End Dimensions of Valves.
- c. ANSI/ASME B16.34 - Valves-Flanged, Threaded and Welding End.
- d. ANSI/ASME B31.1 - Power Piping.
- e. ANSI/ASME B31.9 - Building Services Piping.
2. American Water Works Association (AWWA):
 - a. ANSI/AWWA C606 – AWWA Standard for Grooved and Shouldered Joints.
3. ASTM International (ASTM):
 - a. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. ASTM A 536 - Standard Specification for Ductile Iron Castings.
4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. Manufacturers Standardization Society (MSS):
 - a. MSS SP-45 - Bypass and Drain Connections.
 - b. MSS SP-67 - Butterfly Valves.
 - c. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
 - d. MSS SP-110 - Ball Valves Treaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:



- 1) Two-piece, full-port, bronze ball valves with bronze trim.
- 2) Three-piece, full-port, bronze ball valves with bronze trim.
- 3) Iron ball valves.
- 4) Iron, grooved-end butterfly valves.
- 5) Iron, grooved-end swing check valves.
- 6) Chain wheels.
- b. Shop Drawings:
 - 1) Coordination Drawings.

B. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the general purpose valves.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Prepare valves for shipping as follows:
 - a. Protect the valves' internal parts against rust and corrosion.
 - b. Protect the valves' threads, flange faces, grooves, and weld ends.
 - c. Set ball valves to the open position to minimize exposure of their functional surfaces.
 - d. Set butterfly valves to the closed position or slightly open position.
 - e. Block check valves in either the closed or open position.

B. Storage and Handling Requirements:

1. Take the following precautions during the storage of valves:
 - a. Maintain valve end protection.
 - b. Store valves indoors, and maintain the temperature higher than the ambient dew point.
 - 1) If valves must be stored outdoors, store the valves off the ground in watertight enclosures.
2. Use a sling to handle large valves.
 - a. Rig the slings so exposed parts are not damaged.
 - b. Do not use the valve's hand wheels or stems as lifting or rigging points.



- C. Packaging Waste Management:
 - 1. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
 - 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 VALVE ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain each type of valve from single source from single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Pressure and Temperature Ratings:
 - a. Provide valves having valve pressure and temperature ratings not less than those indicated in the Contract Documents, and as required for the system pressures and temperatures.
- D. Design Criteria:
 - 1. American Society of Mechanical Engineers (ASME) Compliance:
 - a. For ferrous valves, provide valves complying with the dimension and design criteria requirements specified in ANSI/ASME B16.10 and ANSI/ASME B16.34.
 - b. For power piping valves, provide valves complying with the requirements specified in ANSI/ASME B31.1.
 - c. For building services, provide piping valves complying with the requirements specified in ANSI/ASME B31.9.



2. Valve Sizes:
 - a. Unless otherwise indicated, provide valves of the same size as the upstream piping.
3. Valve Actuator Types:
 - a. Provide valve actuators for the following applications of the types specified:
 - 1) For quarter-turn valves having nominal pipe sizes of 8 inches and smaller [NPS 6 (DN 150)], provide hand levers.
 - 2) For quarter-turn valves having nominal pipe sizes of 8 inches and larger [NPS 8 (DN 200)], provide gear actuators.
 - 3) For valves other than quarter-turn types, provide hand wheels.
4. Valves in Insulated Piping:
 - a. For valves in insulated piping, provide valves having 2-inch (50mm) stem extensions.
 - b. Ball Valves:
 - 1) Provide insulated ball valves having an extended operating handle made from non-thermal-conductive material, and a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation.
 - c. Butterfly Valves:
 - 1) Provide insulated butterfly valves having an extended neck.
5. Valve-End Connections:
 - a. Flanged End Connections:
 - 1) For iron valves having flanged end connections, provide flanges complying with the requirements specified in ANSI/ASME B16.1.
 - b. Grooved End Connections:
 - 1) For valves having grooved end connections, provide valves having grooves complying with the requirements specified in ANSI/AWWA C606.
 - c. Valve End Selection:
 - 1) Except for wafer type valves, select valves having the type of end connections specified herein for the following applications:
 - a) Valves in Copper Tubing:
 - (1) For copper tubing having nominal pipe sizes of 2 inches [NPS 2 (DN 50)] and smaller, provide threaded ends except where an option to use solder-joint valve-ends is specified.
 - (2) For copper tubing having nominal pipe sizes of 2-1/2 inches to 4 inches [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)], provide flanged ends except where an option to use threaded valve-ends is specified.
 - (3) For copper tubing having nominal pipe sizes of 5 inches [NPS 5 (DN 125)] and larger, provide flanged ends.
 - b) Valves in Steel Piping:



- (1) For steel piping having nominal pipe sizes of 2 inches [NPS 2 (DN 50)] and smaller, provide threaded ends.
 - (2) For steel piping having nominal pipe sizes of 2-1/2 inches to 4 inches [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)], provide flanged ends except where an option to use threaded valve-ends is specified.
 - (3) For Steel Piping having nominal pipe sizes of 5 inches [NPS 5 (DN 125)] and larger, provide flanged ends.
 - c) Valves in Grooved-End Copper Tubing or Steel Piping:
 - (1) For valves in grooved-end copper tubing or steel piping, grooved valve ends may be provide.
6. Valve Bypass and Drain Connections:
 - a. Provide valve bypass and drain connections complying with the requirements specified in MSS SP-45.
7. Valve Applications:
 - a. Chilled-Water Valves:
 - 1) For chilled-water valves having nominal pipe sizes of 2 inches [NPS 2 (DN 50)] and smaller, provide the following types of valves:
 - a) Bronze Valves:
 - (1) Bronze valves having solder-joint ends instead of threaded ends may be provided.
 - b) Ball Valves:
 - (1) Two or three piece, fullport, bronze ball valves with bronze trim may be provided.
 - 2) For chilled-water valves having nominal pipe sizes of 2-1/2 inches [NPS 2-1/2 (DN 65)] and larger, provide the following types of valves:
 - a) Iron Valves:
 - (1) For chilled-water valves having nominal pipe sizes of 2-1/2 inches to 4 inches [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)], iron valves having grooved ends instead of flanged ends may be provided.
 - b) Ball Valves:
 - (1) For chilled-water valves having nominal pipe sizes of 2-1/2 inches to 10 inches [NPS 2-1/2 to NPS 10 (DN 65 to DN 250)], provide Class 150 iron ball valves.
 - c) Butterfly Valves:
 - (1) For chilled-water valves having nominal pipe sizes of 2-1/2 inches to 12 inches [NPS 2-1/2 to NPS 10 (DN 65 to DN 300)], provide iron, grooved-end butterfly valves rated for 175 cold working pressure (CWP).
 - d) Check Valves:
 - (1) For chilled-water valves having nominal pipe sizes of 3 inches to 12 inches [NPS 2-1/2 to NPS 10 (DN 80 to



- DN 300)], provide iron, grooved-end check valves rated for 300 cold working pressure (CWP).
- b. If valve types for an application are not otherwise indicated in the Contract Documents, provide the following valve types:
 - 1) Shutoff Service:
 - a) Provide ball or butterfly valves for shutoff service.
 - 2) Dead-End Service:
 - a) Provide single-flange (lug) type butterfly valves for dead-end service.
 - 3) Throttling Service:
 - a) Provide ball or butterfly valves for throttling service.
 - 4) Pump-Discharge Check Valves:
 - a) For pump discharges having nominal pipe sizes of 2 inches [NPS 2 (DN 50)] and smaller, provide bronze swing check valves having a bronze disc.
 - b) For pump discharges having nominal pipe sizes of 2-1/2 inches [NPS 2-1/2 (DN 65)] and larger, provide iron swing check valves having a lever and weight or a spring; or provide iron center-guided, metal-seat or resilient-seat, check valves.
 - c. If valves with the specified steam working pressure (SWP) classes or cold working pressure (CWP) ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
8. Product Data:
- a. Submit Product Data for each type of valve indicated in the Contract Documents to the Program/Project Manager for approval.
- E. Materials:
- 1. Specialty Valves:
 - a. For specialty valves specified in other Sections and applicable only to specific piping applications, provide valves as specified in those other Sections.
 - 2. Bronze Ball Valves:
 - a. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1) Provide two-piece, full-port, bronze ball valves with bronze trim complying with the requirements specified in MSS SP-110.
 - 2) Steam Working Pressure (SWP) Rating:
 - a) Provide valves having a 150 psig (1035 kPa) steam working pressure (SWP).
 - 3) Cold Working Pressure (CWP) Rating:
 - a) Provide valves having a 600 psig (4140 kPa) cold working pressure (CWP).
 - 4) Body Design:
 - a) Provide valves having a two piece body design.
 - 5) Body Material:
 - a) Provide valves having bronze bodies.



- 6) Ends:
 - a) Provide valves having soldered ends.
- 7) Seats:
 - a) Provide valves having polytetrafluoroethylene (PTFE) or tetrafluoroethylene (TFE) seats.
- 8) Stems:
 - a) Provide valves having bronze stems.
- 9) Balls:
 - a) Provide valves having chrome-plated brass balls.
- 10) Ports:
 - a) Provide valves having full ports.
- 11) Manufacturers:
 - a) American Valve, Inc., <http://www.americanvalve.com>.
 - b) Conbraco Industries, Inc.; Apollo® Valves, <http://www.apollovalves.com>.
 - c) Crane Co.; Crane Valve Group; Crane Valves, <http://www.cranesupply.com/Products/Valves/Valves.aspx>.
 - d) Hammond Valve, <http://www.hammondvalve.com>.
 - e) Milwaukee Valve Company, <http://www.milwaukeevalve.com>.
 - f) NIBCO® INC., <http://www.nibco.com/cms.do>.
 - g) Red-White Valve Corporation, <https://www.redwhitevalvecorp.com/>.
 - h) Watts Regulator Co.; a division of Watts Water Technologies, Inc., <http://www.watts.com>.
 - i) Approved equal.
- b. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1) Provide three-piece, full-port, bronze ball valves with bronze trim complying with the requirements specified in MSS SP-110.
 - 2) Steam Working Pressure (SWP) Rating:
 - a) Provide valves having a 150 psig (1035 kPa) steam working pressure (SWP).
 - 3) Cold Working Pressure (CWP) Rating:
 - a) Provide valves having a 600 psig (4140 kPa) cold working pressure (CWP).
 - 4) Body Design:
 - a) Provide valves having a three piece body design.
 - 5) Body Material:
 - a) Provide valves having bronze bodies.
 - 6) Ends:
 - a) Provide valves having soldered or grooved ends.
 - 7) Seats:
 - a) Provide valves having polytetrafluoroethylene (PTFE) or tetrafluoroethylene (TFE) seats.
 - 8) Stems:
 - a) Provide valves having bronze stems.



- 9) Balls:
 - a) Provide valves having chrome-plated brass balls.
- 10) Ports:
 - a) Provide valves having full ports.
- 11) Manufacturers:
 - a) Conbraco Industries, Inc.; Apollo® Valves, <http://www.apollovalves.com>.
 - b) DynaQuip Controls, <http://www.dynaquip.com>.
 - c) Hammond Valve, <http://www.hammondvalve.com>.
 - d) Milwaukee Valve Company, <http://www.milwaukeevalve.com>.
 - e) NIBCO® INC., <http://www.nibco.com/cms.do>.
 - f) Red-White Valve Corporation, <https://www.redwhitevalvecorp.com/>.
 - g) Approved equal.
- 3. Iron Ball Valves:
 - a. Provide Class 125, iron ball valves complying with the requirements specified in MSS SP-72.
 - b. Cold Working Pressure (CWP) Rating:
 - 1) Provide valves having a 200 psig (1380 kPa) cold working pressure (CWP).
 - c. Body Design:
 - 1) Provide valves having a split body design.
 - d. Body Material:
 - 1) Provide valves having bodies fabricated from gray iron complying with the requirements specified in ASTM A 126.
 - e. Ends:
 - 1) Provide valves having flanged or grooved ends.
 - f. Seats:
 - 1) Provide valves having polytetrafluoroethylene (PTFE) or tetrafluoroethylene (TFE) seats.
 - g. Stems:
 - 1) Provide valves having stainless steel stems.
 - h. Balls:
 - 1) Provide valves having stainless steel balls.
 - i. Ports:
 - 1) Provide valves having full ports.
 - j. Manufacturers:
 - 1) American Valve, Inc., <http://www.americanvalve.com>.
 - 2) Conbraco Industries, Inc.; Apollo® Valves, <http://www.apollovalves.com>.
 - 3) Kitz Corporation, <http://www.kitz.com>.
 - 4) Sure Flow Equipment Inc., <http://www.sureflowequipment.com>.
 - 5) Watts Regulator Co.; a division of Watts Water Technologies, Inc., <http://www.watts.com>.
 - 6) Approved equal.



4. Iron, Grooved-End Butterfly Valves:
 - a. Provide iron, grooved-end, 175 cold working pressure (1200 kPa) valves complying with the requirements for Type I butterfly valves specified in MSS SP-67:
 - 1) Body Material:
 - a) Provide valves having coated, ductile iron bodies.
 - 2) Stem:
 - a) Provide valves having a two-piece stainless steel stem.
 - 3) Disc:
 - a) Provide valves having coated, ductile iron valve discs.
 - 4) Seal:
 - a) Provide valves having ethylene propylene copolymer rubber (EPDM) seals.
 - 5) Manufacturers:
 - a) Kennedy Valve; a division of McWane, Inc., <http://www.kennedyvalve.com>.
 - b) Shurjoint Piping Products, <http://www.shurjoint.com>
 - c) Tyco Fire Products LP; Grinnell Mechanical Products, <http://www.grinnell.com>.
 - d) Victaulic Company, <http://www.victaulic.com>.
 - e) Approved equal.
5. Iron, Grooved-End Swing Check Valves:
 - a. Provide iron, grooved-end swing check valves.
 - 1) Cold Working Pressure (CWP) Rating:
 - a) Provide valves having a 300 psig (2070 kPa) cold working pressure (CWP).
 - b. Body Material:
 - 1) Provide valves having bodies fabricated from ductile iron complying with the requirements specified in ASTM A 536.
 - c. Seals:
 - 1) Provide valves having ethylene propylene copolymer rubber (EPDM) seals.
 - d. Discs:
 - 1) Provide valves having spring operated, ductile iron or stainless steel valve discs.
 - e. Manufacturers:
 - 1) Anvil International, Inc., <http://www.anvilintl.com>.
 - 2) Shurjoint Piping Products, <http://www.shurjoint.com>
 - 3) Tyco Fire Products LP; Grinnell Mechanical Products, <http://www.grinnell.com>.
 - 4) Victaulic Company, <http://www.victaulic.com>.
 - 5) Approved equal.

2.02 ACCESSORIES

A. Chain Wheels:



1. Provide a valve actuation assembly consisting of a sprocket rim, brackets, and a chain.
 - a. Brackets:
 - 1) Provide the type, number, and size of brackets and fasteners required to mount the actuator on the valve.
 - b. Attachment:
 - 1) Provide attachments for connection to ball and butterfly valve stems.
 - c. Sprocket Rim with Chain Guides:
 - 1) Provide ductile or cast iron sprocket rims with chain guides of the type and size required for the valve.
 - d. Chain:
 - 1) Provide hot-dip, galvanized steel chains of the size required to fit the sprocket rim.
 2. Manufacturers:
 - a. Babbitt Steam Specialty Co., <http://www.babbittsteam.com>.
 - b. Roto Hammer Industries, <http://www.rotohammerinc.com>.
 - c. Trumbull Industries, <http://www.trumbull.com>.
 - d. Approved equal.
- B. Valve Tags and Schedules:
1. For valve tags and schedules, provide tags and schedules complying with the requirements specified in Section 15075, Mechanical Identification.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Make a thorough examination of the areas to receive the Work of this Section to verify there are ready for the installation of the general purpose valves.
- B. Evaluation and Assessment:
1. Prior to installing the general purpose valves, notify the Program/Project Manager in writing of defects discovered which could affect the satisfactory completion of the Work of this Section.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect adjacent areas from damage resulting from installation of the general purpose valves.
- B. Demolition / Removal:
1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.



3.03 INSTALLATION

- A. Locate valves to permit easy access, and provide separate support for the valves where necessary.
- B. Install valves in horizontal piping with their stems at or above the center of the pipe.
- C. Install valves in a position allowing for full stem movement.
- D. Swing Check Valves:
 - 1. Install swing check valves in the horizontal position, with hinge pin level and aligned for the proper direction of flow.
- E. Special Techniques:
 - 1. Chain Wheels:
 - a. For ball and butterfly valves having a nominal pipe size 4 inches [NPS 4 (DN 100)] and larger and more than 96 inches (2400mm) above the floor, provide chain wheels on the valve operators.
 - 1) Extend the chains to 60 inches (1520mm) above the finished floor.
- F. Systems Integration:
 - 1. At each piece of equipment, provide valves having unions or flanges; and arranged to allow service, maintenance, and equipment removal without the need to shut down the system.

3.04 REPAIR/RESTORATION

- A. Do not attempt to repair defective valves; replace defective valves with new valves.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Inspections:
 - a. Examine each valve interior for cleanliness, freedom from foreign matter, and corrosion.
 - b. Operate the valves in positions ranging from fully open to fully closed.
 - 1) Examine the guides and seats made accessible by such operations.
 - c. Examine the connections on the valve and mating pipe for form and cleanliness.
 - d. Examine mating flange faces for conditions that might cause leakage.
 - 1) Check the bolting for proper size, length, and material.
 - 2) Verify that the gasket is the proper size, that its material composition is suitable for service, and that it is free from defects and damage.



- B. Non-Conforming Work
 - 1. Replace valves if persistent leaking occurs.

3.06 SYSTEM STARTUP

- A. Commissioning:
 - 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.07 ADJUSTING

- A. Adjust or replace valve packing after the piping systems have been tested and put into service, but before final adjusting and balancing.

3.08 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.09 PROTECTION

- A. Take steps to insure that installed general purpose valves are protected during subsequent construction activities.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for the general purpose valves for inclusion in emergency manuals and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.
 - 2. Submit the operation and maintenance data for the general purpose valves to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.





SECTION 15122

EXPANSION FITTINGS AND LOOPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of expansion fittings and loops:
 - a. Flexible-hose packless expansion joints.
 - b. Grooved-joint expansion joints.
 - c. Alignment guides and anchors.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene propylene diene terpolymer M-class rubber.
- B. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME B18.10 - Track Bolts and Nuts.
 - b. ASME B31.9 - Building Services Piping.
 - c. ASME BPVC-IX - ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.
 - 2. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM A 183 – Standard Specification for Carbon Steel Track Bolts and Nuts.
 - d. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - e. ASTM C 881/C 881M – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - f. ASTM F 844 – Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
 - 3. American Water Works Association (AWWA):
 - a. ANSI/AWWA C606 – AWWA Standard for Grooved and Shouldered Joints.



4. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
6. The Expansion Joint Manufacturers Association, Inc. (EJMA):
 - a. EJMA Standards.
7. Fluid Sealing Association (FSA):
 - a. FSA-NMEJ-702 – Rubber Flanged Non-Metallic Expansion Joint Installation, Maintenance and Storage.
8. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
9. Manufacturers Standardization Society (MSS):
 - a. ANSI/MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Flexible-Hose packless expansion joints.
 - 2) Grooved-joint expansion joints.
 - 3) Alignment guides.
 - 4) Anchors.
 - b. Shop Drawings:
 - 1) Anchor details.
 - 2) Alignment guide details.
 - c. Certificates:
 - 1) Mechanical expansion joint manufacturer's Certificates of Compliance.
 - d. Delegated Design Submittals:
 - 1) Calculations for thermal expansion of the piping systems, and as required for selecting and designing the expansion joints, loops, and swing connections.
 - e. Qualification Statements:
 - 1) Welding procedure specifications (WPS) test records.
 - 2) Welding Certificates.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Fastener manufacturer's written installation instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Maintenance data for the expansion joints.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Welding Qualifications:

- a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in AWS D1.1/D1.1M and ASME BPVC-IX, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in AWS D1.1/D1.1M and ASME BPVC-IX.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

B. Certifications:

1. Manufacturer's Certificates of Compliance:

- a. For each type of mechanical expansion joint, submit Manufacturer's Certificates of Compliance wherein the manufacturer of these items certifies that they comply with the specified requirements, to the Program/Project Manager for approval.



1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Coordinate delivery to the Site of anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages.
 - 2. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 - 1. Protect fastener products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 EXPANSION FITTING AND LOOP ASSEMBLIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Compatibility:
 - a. Provide products suitable for the piping's service fluids, materials, working pressures, and temperatures.
 - 2. Capability:



- a. Provide products capable of absorbing 200 percent of the maximum axial movement between anchors.
- D. Design Criteria:
 - 1. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of product proposed for the Work of this Section.
 - 1) Prepare an Expansion Fittings and Loops Schedule that indicates the type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 2. Shop Drawings:
 - a. For each anchor and alignment guide, prepare Shop Drawings that include the following information:
 - 1) Anchor Details:
 - a) Detail the fabrication of each anchor indicated.
 - b) Show the dimensions and methods of assembly and attachment to the building structure.
 - 2) Alignment Guide Details:
 - a) Detail field assembly and attachment to the building structure.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
 - 3. Calculations:
 - a. Calculate the thermal expansion requirements of the piping systems, and perform the design calculations required for selecting and designing the expansion joints, loops, and swing connections.
 - 1) For each anchor and alignment guide, prepare calculations required for the anchors and alignment guides to comply with the specified performance requirements and design criteria including analysis data signed and sealed by the qualified Professional Engineer responsible for performing the calculations.
 - b. Submit the calculations to the Program/Project Manager for approval.
- E. Materials:
 - 1. Packless Expansion Joints:
 - a. Flexible-Hose Packless Expansion Joints:
 - 1) Provide manufactured flexible-hose packless expansion joint assemblies having inlet and outlet elbow fittings, and 2 flexible-metal-hose legs joined by a long-radius, 180-degree return bend or a center section of flexible hose.
 - 2) Flexible Hose:
 - a) Provide corrugated-metal inner hoses and braided outer sheaths.
 - 3) Expansion Joints for Copper Tubing:



- a) For copper tubing having nominal pipe sizes of 2 inches (DN 50) and smaller, provide copper-alloy fittings with solder-joint end connections, and bronze hoses rated for 450 psig at 70 degrees Fahrenheit (3100kPa at 21 degrees Celsius) with single-braid bronze sheaths rated for 340 psig at 450 degrees Fahrenheit (2340kPa at 232 degrees Celsius).
 - 4) Expansion Joints for Steel Piping:
 - a) For steel piping having nominal pipe sizes of 2-1/2 inches (DN 65) to 6 inches (DN 150), provide expansion joints having carbon-steel fittings with grooved end connections.
 - b) Provide stainless-steel hoses and double-braid, stainless-steel sheaths rated for 275 psig (1900kPa) at 70 degrees Fahrenheit (21 degrees Celsius) and for 200 psig (1380kPa) at 600 degrees Fahrenheit at 315 degrees Celsius) ratings.
 - 5) Manufacturers:
 - a) Flex-Hose Co., Inc., <http://www.flexhose.com>.
 - b) Flexicraft Industries, <http://www.flexicraft.com>.
 - c) Flex-Pression Limited, <http://www.flexpression.com>.
 - d) Metraflex, Inc., <http://www.metraflex.com/index.php>.
 - e) Approved equal.
2. Grooved-Joint Expansion Joints:
 - a. Provide factory-assembled grooved-joint expansion joints consisting of several grooved-end pipe nipples, couplings, and grooved joints complying with the requirements for grooved joints specified in ANSI/AWWA C606.
 - b. Nipples:
 - 1) Provide galvanized pipe nipples with grooved ends complying with the requirements for Schedule 40, Type E or S, steel pipe specified in ASTM A 53/A 53M.
 - c. Couplings
 - 1) For each expansion joint, provide a minimum of 7 flexible type couplings sized for the steel-pipe dimensions.
 - a) Provide ferrous housing sections, ethylene propylene diene terpolymer M-class rubber (EPDM) gaskets suitable for cold and hot water, and bolts and nuts.
 - d. Manufacturers:
 - 1) Anvil International, Inc., a subsidiary of Mueller Water Products, Inc., <http://www.anvilintl.com>.
 - 2) Shurjoint Piping Products, <http://www.shurjoint.com/eng/>.
 - 3) Victaulic Company of America, <http://www.victaulic.com>.
 - 4) Approved equal.
3. Alignment Guides and Anchors:
 - a. Alignment Guides:
 - 1) Provide steel, factory-fabricated alignment guides consisting of a bolted two-section outer cylinder and base for attaching the



- alignment guides to the structure, and a two-section guiding spider for bolting the alignment guides to the pipe.
- 2) Manufacturers:
 - a) Advanced Thermal Systems, Inc., <http://www.advancedthermal.net>.
 - b) Flex-Hose Co., Inc., <http://www.flexhose.com>.
 - c) Flexicraft Industries, <http://www.flexicraft.com>.
 - d) Flex-Weld, Inc., <http://www.flex-weld.com>.
 - e) Hyspan Precision Products, Inc., <http://www.hyspan.com>
 - f) Metraflex, Inc., <http://www.metraflex.com/index.php>.
 - g) Approved equal.
 - b. Anchor Materials:
 - 1) Steel Shapes and Plates:
 - a) Provide steel shapes and plates complying with the requirements specified in ASTM A 36/A 36M.
 - 2) Bolts and Nuts:
 - a) Provide steel hex head bolts and nuts complying with the requirements specified in ASME B18.10 or ASTM A 183.
 - 3) Washers:
 - a) Provide plain, flat steel washers complying with the requirements specified in ASTM F 844.
 - 4) Mechanical Fasteners:
 - a) Provide expansion plug anchors designed for use in hardened Portland cement concrete, that have insert-wedge-type studs, and that have tension and shear capacities appropriate for the application.
 - (1) Studs:
 - (a) Provide threaded, zinc-coated carbon steel studs.
 - (2) Expansion Plugs:
 - (a) Provide zinc-coated steel expansion plugs.
 - (3) Washers and Nuts:
 - (a) Provide zinc-coated steel washers and nuts.
 - 5) Chemical Fasteners:
 - a) Provide chemical bonding-system type anchors designed for use in hardened Portland cement concrete, that have insert-type studs, and that have tension and shear capacities appropriate for the application.
 - (1) Bonding Material:
 - (a) Provide bonding material complying with the requirements for Type IV, Grade 3, two-component epoxy resin specified in ASTM C 881/C 881M, and that is suitable for the surface temperature of the hardened concrete where the fastener is to be installed.
 - (2) Studs:



- (a) Provide zinc-coated carbon steel studs complying with the requirements specified in ASTM A 307, and having a continuous thread unless otherwise indicated in the Contract Documents.
 - (3) Washers and Nuts:
 - (a) Provide zinc-coated steel washers and nuts.
- F. Shop Fabrication:
- 1. Fabricate steel anchors by welding steel shapes, plates, and bars in accordance with the requirements specified in ASME B31.9 and AWS D1.1/D1.1M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the elements and surfaces to receive expansion fittings and loops for compliance with the required clearances and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the expansion fittings and loops.
- B. Surface Preparation:
 - 1. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.
- C. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Expansion Joints:
 - 1. Provide expansion joints sized to match the size of the piping in which the expansion joint is installed.
 - 2. Packed-Type Expansion Joints:
 - a. Install packed-type expansion joints having packing suitable for the fluid service.



3. Metal-Bellows Expansion Joints:
 - a. Install metal-bellows expansion joints in accordance with the requirements specified in the EJMA Standards.
 4. Rubber Packless Expansion Joints:
 - a. Install rubber packless expansion joints in accordance with the requirements specified in FSA-NMEJ-702.
 5. Grooved-Joint Expansion Joints:
 - a. Install grooved-joint expansion joints to grooved-end steel piping.
- B. Pipe Loops and Swing Connections:
1. Install pipe loops cold-sprung in tension or compression as required to partly absorb the tension or compression produced during the anticipated change in temperature.
 2. Connect the risers and branch connections to the mains with at least 5 pipe fittings, including the tee in the main.
 3. Connect the risers and branch connections to the terminal units with at least 4 pipe fittings, including the tee in the riser.
 4. Connect the mains and branch connections to the terminal units with at least 4 pipe fittings, including the tee in the main.
- C. Alignment Guides and Anchors:
1. To guide expansion and to avoid end-loading and torsional stresses, provide alignment guides.
 2. Provide 2 alignment guides on each side of pipe expansion fittings and loops.
 - a. Install the alignment guides nearest to the expansion joint not more than 4 pipe diameters from the expansion joint.
 3. Attach alignment guides to the pipe, and secure the guides to building structure.
 4. Locate anchors so stresses exceeding those permitted by ASME B31.9 will be prevented, and so loading and stresses will not be transferred to the connected equipment.
 5. Anchor Attachments:
 - a. Anchor Attachment to Steel Pipe:
 - 1) Weld anchors to steel pipe in accordance with the requirements specified in ASME B31.9 and ASME BPVC-IX.
 - b. Anchor Attachment to Copper Tubing:
 - 1) Attach anchors to copper tubing using pipe hangers that are bolted to the anchor, and U-bolts complying with the requirements for Type 24 U-bolts specified in ANSI/MSS SP-69.
- D. Interface with Other Work:
1. Anchor Attachments:
 - a. Anchor Attachment to Steel Structural Members:



- 1) Attach anchors to steel structural members by welding in accordance with the requirements specified in ASME B31.9 and AWS D1.1/D1.1M.
- b. Anchor Attachment to Concrete Structural Members:
 - 1) Attach anchors to concrete structural members using fasteners.
 - a) Comply with the fastener manufacturer's installation instructions.
 - (1) Submit the fastener manufacturer's written installation instructions to the Program/Project Manager for information.

3.04 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 PROTECTION

- A. Protect installed expansion fittings and loops during the remainder of the construction period to prevent damage from other construction work.

3.06 MAINTENANCE

- A. Submit maintenance data for the expansion joints for inclusion in Operation and Maintenance Manuals to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/03/2017	N/A	All	First edition.



SECTION 15128

METERS AND GAGES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for meters and gages, including the following:
 - a. Bimetallic-actuated thermometers.
 - b. Liquid-in-glass thermometers.
 - c. Dial-type pressure gages.
 - d. Gage attachments.
 - e. Sight flow indicators.
 - f. Test plugs.
 - g. Test-plug kits.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene propylene diene terpolymer M-class rubber.
- B. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. ASME B1.1 – Unified Inch Screw Threads, (UN and UNR Thread Form).
 - b. ASME B1.20.1 – Pipe Threads, General Purpose (Inch)
 - c. ASME B40.100 – Pressure Gauges and Gauge Attachments.
 - d. ASME B40.200 – Thermometers, Direct Reading and Remote Reading.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the layout and installation of the meters and gages with other construction including conduit, piping, equipment, and adjacent surfaces.
 - a. Maintain the required workspace clearances and required clearances for equipment access doors and panels.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Bimetallic-actuated thermometers.
 - 2) Metal-case, compact-style, liquid-in-glass thermometers.
 - 3) Metal-case, industrial-style, liquid-in-glass thermometers.
 - 4) Duct-thermometer mounting brackets.
 - 5) Thermowells.
 - 6) Pressure gages.
 - 7) Snubbers.
 - 8) Siphons.
 - 9) Ball valves.
 - 10) Test plugs.
 - 11) Test-plug kit.
 - 12) Sight flow indicators.
 - b. Shop Drawings:
 - 1) Wiring diagrams for power, signal, and control wiring.
 - c. Certificates:
 - 1) Manufacturer's Certificates of Compliance for each type of meter and gage.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Meter manufacturer's written installation instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the meters and gages provided under this Section.

1.05 QUALITY ASSURANCE

A. Certifications:

1. Manufacturer's Certificates of Compliance:
 - a. For each type of meter and gage, submit Manufacturer's Certificates of Compliance wherein the manufacturer of these items certifies that



they comply with the specified requirements, to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 - 1. Store the meters and gages indoors in a clean, dry space having a uniform temperature to prevent condensation.
 - 2. Protect the meters and gages from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 METERS AND GAGES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Accuracy:
 - a. Thermometers:



- 1) Bimetallic-Actuated Thermometers:
 - a) Provide bimetallic-actuated thermometers accurate to plus or minus 1 percent of the scale range.
 - 2) Metal-Case, Liquid-in-Glass Thermometers:
 - a) Provide metal-case, compact-style, liquid-in-glass thermometers accurate to plus or minus 1 percent of the scale range or one scale division, but not inaccurate to more than 1.5 percent of the scale range.
 - b. Pressure Gages:
 - 1) Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - a) Provide direct-mounted, metal-case, dial-type pressure gages having Grade A accuracy, and accurate to plus or minus 1 percent of the middle half of the scale range.
- D. Design Criteria:
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance of the meters, gages, machines, and equipment.
 2. Thermometers:
 - a. Thermometer Scale-Range Schedule:
 - 1) Chilled-Water Piping:
 - a) Provide thermometers for chilled-water piping having a scale range of 0 degrees Fahrenheit to 100 degrees Fahrenheit (Minus 20 degrees Celsius to plus 50 degrees Celsius).
 - 2) Air Ducts:
 - a) Provide thermometers for air ducts having a scale range of 0 degrees Fahrenheit to 150 degrees Fahrenheit (Minus 20 degrees Celsius to plus 70 degrees Celsius).
 - b. Install thermometers in the following locations:
 - 1) On the inlet and outlet of each hydronic zone.
 - 2) On the inlet and outlet of each hydronic coil in air-handling units.
 - 3) On the 2 inlets and 2 outlets of each hydronic heat exchanger.
 - 4) On the outside-air, return-air, supply-air, and mixed-air ducts.
 3. Pressure Gages:
 - a. Pressure Gage Scale-Range Schedule:
 - 1) Chilled-Water Piping:
 - a) Provide pressure gages for chilled-water piping having a scale range of 0 psi to 100 psi (0kPa to 600kPa).
 - b. Install pressure gages on the suction and discharge of each pump.
 4. Product Data:
 - a. Obtain Product Data for each type of product proposed for the Work of this Section.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 5. Shop Drawings:
 - a. Prepare wiring diagrams for the power, signal, and control wiring to the meters and gages provided under this Section.



- b. Submit the wiring diagrams to the Program/Project Manager for approval.

E. Materials:

1. Bimetallic-Actuated Thermometers:

- a. Provide bimetallic-actuated thermometers complying with the requirements specified in ASME B40.200, and having the following features:
 - 1) Cases:
 - a) Provide liquid-filled and sealed type; stainless steel thermometer cases having a 5-inch (127mm) nominal diameter for the thermometers.
 - 2) Dials:
 - a) Provide non-reflective aluminum thermometer dials having scale markings and scales in degrees Fahrenheit and degrees Celsius permanently etched on the dials.
 - 3) Connectors:
 - a) Provide 1/2-inch (13mm) union joint, adjustable angle, rigid back and rigid bottom type thermometer connectors having unified-inch screw threads that comply with the requirements specified in ASME B1.1.
 - 4) Stems:
 - a) Provide 0.25-inch (6.4mm) or 0.375-inch (9.4mm) diameter stainless steel thermometer stems.
 - 5) Windows:
 - a) Provide plain glass thermometer windows.
 - 6) Rings:
 - a) Provide stainless steel thermometer rings.
 - 7) Element:
 - a) Provide bimetal thermometer coils.
 - 8) Pointers:
 - a) Provide dark-colored metal thermometer pointers.
 - b. Manufacturers:
 - 1) Ashcroft, Inc., <http://www.ashcroft.com>.
 - 2) H. O. Trerice Company, <http://www.trerice.com>.
 - 3) Watts Regulator Co., a Division of Watts Water Technologies Company, <http://www.watts.com>.
 - 4) Weiss Instruments, <http://www.weissinstruments.com>.
 - 5) Approved equal.
2. Metal-Case, Liquid-in-Glass Thermometers:
- a. Compact-Style Thermometers:
 - 1) Provide metal-case, compact-style, liquid-in-glass thermometers complying with the requirements specified in ASME B40.200, and having the following features:
 - a) Cases:



- (1) Unless otherwise indicated in the Contract Documents, provide cast aluminum back angle thermometer cases, having a 6-inch (152mm) nominal size.
- b) Tubes and Tube Backgrounds:
 - (1) Provide glass thermometer tubes having magnifying lens and blue or red organic liquid for indicating the temperature.
 - (2) Provide non-reflective aluminum tube backgrounds having scale markings graduated in degrees Fahrenheit and degrees Celsius permanently etched on the background.
- c) Windows:
 - (1) Provide glass or plastic thermometer windows.
- d) Stems:
 - (1) Provide aluminum or brass stems of a length to suit the thermometer installation.
 - (a) For air-duct installations, provide stems having a ventilated shroud.
 - (b) For thermowell installations, provide bare stems.
- e) Connectors:
 - (1) Provide 3/4-inch (19mm) thermometer connectors having unified-inch screw threads that comply with the requirements specified in ASME B1.1.
- 2) Manufacturers:
 - a) H. O. Trerice Company, <http://www.trerice.com>.
 - b) Approved equal.
- b. Industrial-Style Thermometers:
 - 1) Provide metal-case, industrial-style, liquid-in-glass thermometers complying with the requirements specified in ASME B40.200, and having the following features:
 - a) Case:
 - (1) Unless otherwise indicated in the Contract Documents, provide cast aluminum adjustable angle thermometer cases, having a 7-inch (178mm) nominal size.
 - b) Tubes and Tube Backgrounds:
 - (1) Provide glass thermometer tubes having magnifying lens and blue or red organic liquid for indicating the temperature.
 - (2) Provide non-reflective aluminum tube backgrounds having scale markings graduated in degrees Fahrenheit and degrees Celsius permanently etched on the background.
 - c) Windows:
 - (1) Provide glass thermometer windows.
 - d) Stems:
 - (1) Provide aluminum stems of a length to suit the thermometer installation.



- (a) For air-duct installations, provide stems having a ventilated shroud.
 - (b) For thermowell installations, provide bare stems.
 - e) Connectors:
 - (1) Provide 1-1/4-inch (32mm) thermometer connectors having unified-inch screw threads that comply with the requirements specified in ASME B1.1.
 - 2) Manufacturers:
 - a) Flo-Fab, Inc., <http://www.flofab.com/NewWeb/newflo/main.asp>.
 - b) Palmer Wahl Instrumentation Group, <http://www.palmerwahl.com>.
 - c) Tel-Tru Manufacturing Company, <http://www.teltru.com>.
 - d) H. O. Trerice Company, <http://www.trerice.com>.
 - e) Weiss Instruments, <http://www.weissinstruments.com>.
 - f) Approved equal.
- 3. Duct-Thermometer Mounting Brackets:
 - a. Provide flanged duct-thermometer mounting brackets having screw holes for attachment to air ducts, and designed to hold a thermometer stem.
- 4. Thermowells:
 - a. Provide pressure-tight thermowells complying with the requirements specified in ASME B40.200, having a socket-type fitting designed for insertion into a piping tee fitting, and unless a straight or tapered shank is indicated in the Contract Documents having a stepped shank.
 - 1) For use with copper tubing, provide copper nickel 90-10 (ASME B40.200 designation CNR) thermowells, or copper nickel 70-30 (ASME B40.200 designation CUNI) thermowells.
 - 2) For use with steel piping, provide corrosion-resistant steel (ASME B40.200 designation CRES) thermowells, or steel (ASME B40.200 designation CSA) thermowells.
 - b. Provide thermowells having the following additional features:
 - 1) External Threads:
 - a) Provide external pipe threads complying with the requirements for 1/2 inch (DN 15), 3/4 inch (DN 20), or 1 inch (DN 25) nominal pipe size threads specified in ASME B1.20.1.
 - 2) Internal Threads:
 - a) Provide internal pipe threads having 1/2 inch (13mm), 3/4 inch (19mm), or 1 inch (25mm) screw threads complying with the requirements specified in ASME B1.1.
 - 3) Bore:
 - a) Provide the bore diameter required to match the thermometer bulb or stem.
 - 4) Insertion Length:



- a) Provide the insertion length required to match the thermometer bulb or stem.
 - 5) Lagging Extension:
 - a) For insulated piping and tubing, provide a lagging extension on the thermowells.
 - 6) Bushings:
 - a) Provide bushings for changing the size of the thermowell's internal screw threads to accommodate the size of the thermometer connection.
 - c. Heat-Transfer Medium:
 - 1) Provide a heat-transfer medium for the thermowells consisting of a mixture of graphite and glycerin.
- 5. Pressure Gages:
 - a. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1) Provide direct-mounted, metal-case, dial-type pressure gages complying with the requirements specified in ASME B40.100, and having the following additional features:
 - a) Cases:
 - (1) Provide cast aluminum or drawn steel solid-front, pressure relief type cases having a 6-inch (152mm) nominal diameter.
 - b) Pressure-Element Assemblies:
 - (1) Unless otherwise indicated in the Contract Documents, provide bourdon tube pressure elements.
 - c) Pressure Connections:
 - (1) Unless back-outlet pressure connections are indicated in the Contract Documents, provide brass bottom-outlet type pressure connections having 1/4 inch nominal pipe size pipe threads (DN 8) complying with the requirements specified in ASME B1.20.1.
 - d) Movements:
 - (1) Provide mechanical movements having a link to the pressure element and a connection to the pointer.
 - e) Dials:
 - (1) Provide non-reflective aluminum pressure gage dials having scale markings and scales graduated in psi (kPa) permanently etched on the dials.
 - f) Pointers:
 - (1) Provide dark-colored metal pointers.
 - g) Windows:
 - (1) Provide glass pressure gage windows.
 - h) Rings:
 - (1) Provide stainless steel pressure gage rings.
 - 2) Manufacturers:
 - a) AMETEK, Inc., <http://www.ametek.com>.



- b) Ashcroft, Inc., <http://www.ashcroft.com>.
 - c) Ernst Flow Industries, <http://www.ernstflow.com>.
 - d) Flo-Fab, Inc.,
<http://www.flofab.com/NewWeb/newflo/main.asp>.
 - e) H. O. Trerice Company, <http://www.trerice.com>.
 - f) Watts Regulator Co., a Division of Watts Water Technologies Company, <http://www.watts.com>.
 - g) Weiss Instruments, <http://www.weissinstruments.com>.
 - h) Approved equal.
6. Gage Attachments:
- a. Snubbers:
 - 1) Provide brass snubbers complying with the requirements specified in ASME B40.100, and having 1/4 inch nominal pipe size (DN 8) pipe threads complying with the requirements specified in ASME B1.20.1 and a piston-type surge-dampening device.
 - 2) For snubbers used on insulated piping, provide extensions.
 - b. Siphons:
 - 1) Provide siphons consisting of a loop-shaped section of brass pipe with 1/4 inch nominal pipe size (DN 8) pipe threads complying with the requirements specified in ASME B1.20.1.
 - c. Ball Valves:
 - 1) Provide brass ball valves having 1/4 inch nominal pipe size (DN 8) pipe threads complying with the requirements specified in ASME B1.20.1.
7. Sight Flow Indicators:
- a. Provide inline sight flow indicators designed for visual verification of flow, and each having a bronze or stainless-steel body, a sight glass and ball, a flapper or paddle wheel indicator, and threaded or flanged ends.
 - b. Pressure Rating:
 - 1) Provide sight flow indicators having a pressure rating of at least 125 psig (860kPa).
 - c. Temperature Rating:
 - 1) Provide sight flow indicators having a temperature rating of at least 200 degrees Fahrenheit (93 degrees Celsius).
 - d. End Connections:
 - 1) For sight flow indicators having nominal pipe sizes of 2 inches (DN 50) and smaller, provide threaded end connections.
 - 2) For sight flow indicators having nominal pipe sizes of 2-1/2 inches (DN 65) and larger, provide flanged end connections.
 - e. Manufacturers:
 - 1) Archon Industries, Inc., <http://www.archonind.com>.
 - 2) Dwyer Instruments, Inc., <http://www.dwyer-inst.com>.
 - 3) Brooks Instrument, <http://www.brooksinstrument.com>.
 - 4) John C. Ernst Co., Inc., <http://www.johnernst.com>.



- 5) Ernst Flow Industries, <http://www.ernstflow.com>.
 - 6) KOBOLD Instruments, Inc. – USA, <http://www.koboldusa.com>.
 - 7) OPW Engineered Systems, a Dover company, <http://www.opwglobal.com/opw-es>.
 - 8) Penberthy, Tyco Flow Control, <http://www.emerson.com/en-us/automation/valves-actuators-regulators/penberthy>.
 - 9) Approved equal.
8. Test Plugs:
- a. Provide test-station fittings designed for insertion into a piping tee fitting, and having the following additional features:
 - 1) Body:
 - a) Provide brass or stainless steel test plug bodies having core inserts and a gasketed and threaded cap.
 - b) For test plugs used on insulated piping, provide extended stems.
 - 2) Thread Size:
 - a) Provide test plugs having 1/4 inch nominal pipe size (DN 8) pipe threads complying with the requirements specified in ASME B1.20.1.
 - 3) Pressure and Temperature Rating:
 - a) Provide test plugs rated for at least 500 psig at 200 degrees Fahrenheit (3450kPa at 93 degrees Celsius).
 - 4) Core Inserts:
 - a) Provide test plugs fabricated from chlorosulfonated polyethylene synthetic and ethylene propylene diene terpolymer M-class (EPDM) self-sealing rubber.
 - b. Manufacturers:
 - 1) Flow Design, Inc., <http://www.flowdesign.com>.
 - 2) Global Metering Systems, <http://www.globalmeter.com>.
 - 3) Peterson Equipment Co., Inc., <http://www.petesplug.com/about.html>.
 - 4) Sisco Manufacturing Company, Inc., <http://sisco.b2bdd.net/>.
 - 5) H. O. Trerice Company, <http://www.trerice.com>.
 - 6) Watts Regulator Co., a Division of Watts Water Technologies Company, <http://www.watts.com>.
 - 7) Weiss Instruments, <http://www.weissinstruments.com>.
 - 8) Approved equal.

2.02 ACCESSORIES

- A. Test-Plug Kit:
1. Furnish one test-plug kit containing 2 thermometers, 1 pressure gage and adapter, and a carrying case.
 - a. Furnish the thermometer sensing elements, pressure gage, and adapter probes having diameters that fit the test plugs, and having a length sufficient to project into the piping.



- b. Low-Range Thermometer:
 - 1) Furnish a small, bimetallic insertion type thermometer having a 1-inch (25mm) to 2-inch (51mm) diameter dial and a tapered-end sensing element.
 - 2) Furnish a thermometer having a dial range of at least 25 degrees Fahrenheit to 125 degrees Fahrenheit (minus 4 degrees Celsius to plus 52 degrees Celsius).
- c. High-Range Thermometer:
 - 1) Furnish a small, bimetallic insertion type thermometer having a 1-inch (25mm) to 2-inch (51mm) diameter dial and a tapered-end sensing element.
 - 2) Furnish a thermometer having a dial range of at least 0 degrees Fahrenheit to 220 degrees Fahrenheit (minus 18 degrees Celsius to plus 104 degrees Celsius).
- d. Pressure Gage:
 - 1) Furnish a small, bourdon-tube insertion type pressure gage having a 2-inch (51mm) to 3-inch (76mm) diameter dial and probe.
 - 2) Furnish a pressure gage having a dial range of at least 0 psig to 200 psig (0kPa to 1380kPa).
- e. Carrying Case:
 - 1) Furnish a metal or plastic carrying case having formed instrument padding.
- 2. Manufacturers:
 - a. Flow Design, Inc., <http://www.flowdesign.com>.
 - b. Global Metering Systems, <http://www.globalmeter.com>.
 - c. Peterson Equipment Co., Inc., <http://www.petesplug.com/about.html>.
 - d. Sisco Manufacturing Company, Inc., <http://www.siscomfg.com>.
 - e. H. O. Trerice Company, <http://www.trerice.com>.
 - f. Watts Regulator Co., a Division of Watts Water Technologies Company, <http://www.watts.com>.
 - g. Weiss Instruments, <http://www.weissinstruments.com>.
 - h. Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the elements and surfaces to receive meters and gages for compliance with the required clearances and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the meters and gages.

3.03 INSTALLATION

- A. Install permanent indicators in accessible and readable positions on walls or brackets.
- B. For attachment of portable indicators, install connection fittings in accessible locations
- C. Thermowells:
 - 1. Provide thermowells sized to match the thermometer connectors.
 - a. Provide bushings if required to match the thermometers to the connector sizes.
 - 2. Install each thermowell in vertical position in a piping tee, and so their socket extends a minimum of 2 inches (51mm) into the fluid.
 - 3. For thermowells to be installed on insulated piping, provide extensions.
 - 4. Fill the thermowells with heat-transfer medium.
- D. Thermometers:
 - 1. Install direct-mounted thermometers in the thermowells, and adjust the vertical and tilted positions.
 - 2. Attach duct-thermometer mounting brackets in the walls of ducts using screws.
- E. Pressure Gages:
 - 1. Locate the pressure gages on the piping at the most readable position, and install direct-mounted pressure gages in piping tees.
 - 2. Install remote-mounted pressure gages on panels.
 - 3. For each pressure gage for fluids except steam, install a valve and snubber in the piping.
 - 4. For each pressure gage for steam, install a valve and syphon fitting in the piping.
- F. Test Plugs:
 - 1. Install test plugs in piping tees.

3.04 SYSTEM STARTUP

- A. Commissioning:
 - 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, equipment



sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.05 ADJUSTING

- A. After installing meters, calibrate the meters in accordance with the meter manufacturer's installation instructions.
 - 1. Submit the meter manufacturer's written installation instructions to the Program/Project Manager for information.
- B. Adjust the faces of meters and gages to the proper angle for best visibility.

3.06 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect installed meters and gages during the remainder of the construction period to prevent damage to the meters and gages from other construction work.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data for the meters and gages provided under this Section to the Program/Project Manager for inclusion in Operation and Maintenance Manuals.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/03/2017	N/A	All	First edition.





SECTION 15131

PLUMBING PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Materials
 - 2. Domestic Hot Water Circulating Pumps and Controls
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.
 - 2. Hangers and Supports: Section 15060.
 - 3. Mechanical Identification: Section 15075
 - 4. Mechanical Insulation: Section 15080.
 - 5. Domestic Water Piping: Section 15140
 - 6. Sanitary Waste and Vent: Section 15150
 - 7. Electrical Power and Coordination: Division 16.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 48, Specification for Gray Iron Castings.
- B. American Society of Mechanical Engineers (ASME) Pressure Vessel Code and Interpretations shall govern the quality and performance of certain Products as specified herein.
- C. Underwriters' Laboratories, Inc. (UL): Listings and Labels shall govern the quality and performance of certain Products as specified herein.

1.03 WARRANTY

- A. Provide manufacturer's warranty under provisions of Division 1 for pumps and motors.

1.04 MAINTENANCE

- A. Furnish complete service and maintenance pumps for one year from Date of Substantial Completion. Submit copy of service call work order or report, and include description of work performed.

1.05 SUBMITTALS

- A. Section 01330: Submittal Procedures: Submittal procedures.



- B. Product Data:
 - 1. Clearly mark the products and accessories being submitted.
 - 2. Submittals shall clearly indicate compliance with the “Reduction of Lead in Drinking Water Act” 2011
- C. Product Data: Submit product data for but not limited to the following items:
 - 1. Domestic hot Water Circulating Pumps
 - 2. Pump Specialties
- D. Plumbing Specialties: Submit manufacturers catalog information with sizes, capacities, rough-in requirements, service sizes and finishes
- E. Pumps: Include capacities, pump curves, equipment performance and electrical characteristics.
- F. Balancing Report: Include final balancing, adjusting and testing report as part of the Submittals in Section 15050.
- G. [Certificates: Buy America Act Certification.]

1.06 CLOSEOUT SUBMITTALS

- A. Section 01700 – Execution Requirements: Requirements for submittals
- B. Operation and Maintenance Data:
 - 1. Manufacturers of the products specified herein shall include complete instructions with their products giving directions for replacing renewable parts of their products as well as instructions for cleaning the finished surfaces of such products.
 - 2. Include above stated data as part of the submittals of Section 01700 and 15050.

1.07 QUALITY ASSURANCE

- A. Perform Work in accordance with **Phoenix** standard codes.
- B. Perform Work in accordance with **State Municipality of** <_____>
- C. Regulatory Agency Sustainability Approvals:]
- D. [Buy America Act:
 - 1. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.]



- E. [Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.]

1.08 DELIVERY, STORAGE AND HANDLING

- A. Section 01600 – Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Prepare pumps and accessories for shipment to prevent entry of foreign matter into product body.
- C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces

1.09 COORDINATION

- A. Section 01300-Administrative Requirements: Requirements for coordination.

1.10 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS

- A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.
- B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer's product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.



PART 2 PRODUCTS

2.01 DOMESTIC HOT WATER CIRCULATING PUMPS

- A. Acceptable Manufacturers:
 - 1. Taco, Inc.; Model 003; [Model 005]
 - 2. Armstrong Pumps; S Series
 - 3. ITT Bell & Gossett; Series PL
- B. Domestic Hot Water Circulating Pump:
 - 1. Pump Design: UL Listed, direct drive, in-line, horizontal, self-lubricating, stainless steel body [lead-free bronze], stainless steel cartridge, EPDM – chlorine resistant O-rings and gaskets; sweat, threaded or union connections, 125 psi maximum operating pressure and 220°F maximum operating temperature.
 - 2. Shaft: Ceramic [alloy steel-copper].
 - 3. Impeller: Non-metallic.
 - 4. Pump Bearings: Carbon [oil lubricated sleeve].
 - 5. Motor: Permanent split capacitor, impedance protected, built-in thermal overload protection.

2.02 DOMESTIC HOT WATER CIRCULATING PUMPS - CONTROLS

- A. Acceptable Manufacturers:
 - 1. Taco, Inc.; Model #265-3
 - 2. Armstrong Pumps
 - 3. ITT Bell & Gossett
- B. Time clock: UL Listed; 7-day digital programmable timer, LCD readout, maximum 10 on/off settings, 100-hour capacitor back-up for power outages.
- C. Acceptable Manufacturers:
 - 1. Taco, Inc.; Model #563-2
 - 2. Honeywell; Model L4006
 - 3. ITT Bell & Gossett
- D. Aquastat: UL Listed; designed to main system temperatures between 95°F and 115°F, SPDT switch, 5°F fixed differential at mid-scale, pipe mounted.
- E. Acceptable Manufacturers (FOR USE WITH EMERGENCY FIXTURES):
 - 1. Honeywell; Model L6006C
- F. Aquastat: UL Listed; totally enclosed, designed to main system temperatures between 95°F and 115°F, SPDT switch, 5°F fixed differential at mid-scale, pipe mounted.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Section 01300-Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify connections, size, and location are as indicated on Drawings.

3.02 PERFORMANCE

- A. Installation Instructions: Install those Products, as specified previously under PART 2 and not specifically covered for installation herein under PART 3, in strict accordance with manufacturer's installation instructions and at locations indicated on the Drawings.
- B. Equipment support and anchoring as specified in Section 15060.
- C. Electrical Interface: As specified in Section 15050.
- D. Equipment Start-Up: Perform equipment start-up and ensure its proper operation prior to acceptance of Work by the Engineer.

3.03 INSTALLATION

- A. Install pumps in accordance with drawings and manufacturer's instruction.
- B. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation.
- C. Provide necessary piping, fittings, and valves as indicated on drawings.

3.04 INSTALLATION IN-LINE PUMPS

- A. Provide line sized ball valves, strainer and union on pump suction. Provide line sized ball valves, check valve and union on pump discharge. Where valves are included as an integral part of a packaged system omit valve installation.
- B. Refer to pump details for specific valves and piping accessories

3.05 FIELD QUALITY CONTROL

- A. Section 01700 – Execution Requirements: Field inspecting, testing, adjusting and balancing.
- B. Upon completion of installation, examine, adjust and test each pump for proper operation



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 15140

DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for domestic water piping inside buildings.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01732 - Cutting and Patching.
3. Section 01780 - Closeout Submittals.
4. Section 01810 - Commissioning.
5. Section 02316 - Trenching and Backfilling.
6. Section 15050 - Basic Mechanical Materials and Methods.
7. Section 15060 - Hangers and Supports.
8. Section 15145 - Domestic Water Piping Specialties.
9. Section 15410 - Plumbing Fixtures.
10. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. HVAC: Heating, Ventilating, and Air-Conditioning.
2. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME):
 - a. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - b. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.



- c. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings.
- 3. ASTM International (ASTM):
 - a. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
 - b. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric).
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. Copper Development Association Inc. (CDA)
 - a. CDA A4015 - The Copper Tube Handbook.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. Manufacturers Standardization Society (MSS):
 - a. MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.
 - b. MSS SP-123 - Non-Ferrous Threaded and Solder-Joints Unions for Use With Copper Water Tube.
- 8. National Sanitation Foundation (NSF):
 - a. NSF 61 - Drinking Water System Components - Health Effects.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Hard copper tube and fittings.
 - 2) Soft copper tube and fittings.



- 3) Transition couplings.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Leak Test Reports.
 - 2) Inspection Reports.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built drawings of the domestic water system.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 - 1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
 - 2. Protect pipe from impact shocks and free fall during handling.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



PART 2 PRODUCTS

2.01 DOMESTIC WATER PIPING COMPONENTS

- A. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- B. Performance:
 - 1. Seismic Performance:
 - a. Provide soil, waste, and vent piping and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.
- C. Design Criteria
 - 1. Piping System:
 - a. Plans, schematics, and diagrams included in the Contract Drawings indicate the general location and arrangement of piping systems.
 - 1) The indicated locations and arrangements were used to size pipe calculate friction losses, and for compliance with other design considerations.
 - 2) Install piping as indicated unless deviations to the layout are approved by the Program/Project Manager on Coordination Drawings.
 - b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a domestic water piping system with a 125 psig minimum working pressure rating:
 - c. Pipe and Fittings:
 - 1) Unless otherwise indicated, provide transition and special fittings having pressure ratings at least equal to the piping rating.
 - 2) On aboveground piping, flanges may be provided unless otherwise indicated.
 - 3) On aboveground copper tubing, extruded-tee connections and brazed joints may be provided unless otherwise indicated.
 - 4) For domestic water piping under building slabs and sized NPS 4 (DN 100) and smaller on the house side of the water meter,



- provide Type K (Type B) soft copper tube and copper pressure fittings.
- 5) No joints are allowed below slabs.
 - 6) For all sizes of aboveground domestic water piping, provide Type L (Type B) hard copper tube, copper pressure fittings; and soldered joints.
 - 7) For aboveground pressure piping transitions, provide couplings or other manufactured fittings the same size as, and having a pressure rating at least equal to, the piping to be joined.
 - a) Ensure that the ends of the transition couplings are compatible with the piping to be joined.
- d. Valves:
- 1) The types of valves to be provided are typically indicated on the Contract Drawings.
 - 2) Where specific valve types are not indicated, provide the following:
 - a) Shutoff Duty:
 - (1) For NPS 4 (DN 100) piping and smaller, provide bronze ball valves.
 - b) Drain Duty:
 - (1) Provide hose-end drain valves.
- e. Shutoff Valves:
- 1) Install shutoff valve close to the water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.
 - a) For NPS 2 (DN 50) piping and smaller, provide ball valves.
 - b) For NPS 2-1/2 (DN 65) piping and larger, provide butterfly or ball valves.
- f. Drain Valves:
- 1) Provide drain valves for equipment at the base of each water riser, at the low points in horizontal piping, and where required to drain water piping.
 - a) Install hose-end drain valves at low points in water mains, risers, and branches.
 - b) Install stop-and-waste drain valves where indicated.
2. Product Data:
- a. Submit Product Data for the products proposed for the Work of this Section to the Program/Project Manager for approval.

D. Materials

1. Copper Tube:



- a. Hard Copper Tube:
 - 1) Provide hard copper water tube complying with the requirements for drawn temper, Type L (Type B) tube as specified in ASTM B 88 (ASTM B 88M).
 - 2) Copper Pressure Fittings:
 - a) Provide solder-joint fittings fabricated from cast-copper-alloy complying with the requirements specified in ASME B16.18, or from wrought-copper complying with the requirements specified in ASME B16.22.
 - (1) Furnish wrought-copper fittings if indicated on the Contract Drawings.
 - 3) Bronze Flanges:
 - a) Provide bronze flanges complying with the requirements specified for Class 150 in ASME B16.24, with solder-joint ends.
 - (1) Furnish Class 300 flanges if required to match piping.
 - 4) Copper Unions:
 - a) Provide cast-copper-alloy, hexagonal-stock body unions complying with the requirements specified in MSS SP-123, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- b. Soft Copper Tube:
 - 1) Provide soft copper water tube complying with the requirements for annealed temper, Type K (Type A) tube as specified in ASTM B 88 (ASTM B 88M).
 - 2) Copper Pressure Fittings:
 - a) Provide solder-joint fittings fabricated from cast-copper-alloy complying with the requirements specified in ASME B16.18, or from wrought-copper complying with the requirements specified in ASME B16.22.
 - (1) Furnish wrought-copper fittings if indicated on the Contract Drawings.
 - 3) Copper Unions:
 - a) Provide cast-copper-alloy, hexagonal-stock body unions complying with the requirements specified in MSS SP-123, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- 2. Mechanical Sleeve Seals:
 - a. Provide mechanical sleeve seals as specified in Section 15050, Basic Mechanical Materials and Methods.
- 3. Sleeves:



- a. Provide sleeves as specified in Section 15050, Basic Mechanical Materials and Methods.
- 4. Transition Couplings:
 - a. Provide couplings or other manufactured fittings.

2.02 ACCESSORIES

- A. Drain Valves:
 - 1. Provide drain valves as specified in Section 15145, Domestic Water Piping Specialties

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify final equipment locations for roughing-in.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the domestic water system.
- B. Surface Preparation:
 - 1. Perform excavation, trenching, and backfilling, if required, as specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install piping in accordance with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.
 - 1. Install copper tubing under the building slab in accordance with the requirements specified in CDA A4015, The Copper Tube Handbook.
- B. Install cast-iron sleeves with water stops and mechanical sleeve seals at each service pipe penetration through foundation walls.
 - 1. Select the number of interlocking rubber links required to make installation watertight.



- C. Inside the building at each domestic water service entrance, provide a shutoff valve, a hose-end drain valve, a strainer, a pressure gage, and a test tee with a valve.
- D. Install horizontal domestic water piping with a 0.25 percent downward slope toward drain, and install vertical domestic water piping plumb.
- E. Hanger and Supports:
 - 1. Install supports in accordance with the requirements specified in Section 15060, Hangers and Supports.
 - 2. Support vertical piping and tubing at the base and at each floor.
 - 3. For double-rod hangers, the rod diameter may be reduced 1 size down to a minimum of 3/8 inch (10 mm).
 - 4. For horizontal copper tubing, install hangers with the following maximum horizontal spacing and minimum rod diameters:
 - a. For NPS 3/4 (DN 20) and smaller pipe, provide hangers with 3/8-inch (10mm) rods spaced 60 inches (1500mm) apart.
 - b. For NPS 1 and NPS 1-1/4 (DN 25 and DN 32) pipe, provide hangers with 3/8-inch (10mm) rods spaced 72 inches (1800mm) apart.
 - c. For NPS 1-1/2 and NPS 2 (DN 40 and DN 50) pipe, provide hangers with 3/8-inch (10mm) rods spaced 96 inches (2400mm) apart.
 - d. For NPS 2-1/2 (DN 65) pipe, provide hangers with 1/2-inch (13mm) rods spaced 108 inches (2700 mm) apart.
 - e. For NPS 3 to NPS 5 (DN 80 to DN 125) pipe, provide hangers with 1/2-inch (13mm) rods spaced 10 feet (3m) apart.
 - f. For NPS 6 (DN 150) pipe, provide hangers with 5/8-inch (16mm) rods spaced 10 feet (3m) apart.
 - 5. For vertical copper tubing, provide supports spaced every 10 feet (3m).
 - 6. Support piping and tubing not listed herein according to the requirements specified in MSS SP-69 and the manufacturer's written instructions.
- F. Interface with Other Work:
 - 1. Connections:
 - a. Install piping adjacent to equipment and machines so service and maintenance are allowed.
 - b. Connect domestic water piping to exterior water-service piping using a transition fitting to join dissimilar piping materials.
 - c. Connect the domestic water piping to the water-service piping using a shutoff valve, and extend and connect the domestic water piping to the following:
 - 1) Water Heaters:



- a) Provide cold-water supply and hot-water outlet piping of the sizes indicated, but not smaller than the sizes of the water heater connections.
- 2) Plumbing Fixtures:
 - a) Provide cold water and hot water supply piping of the sizes indicated, but not smaller than required by applicable plumbing code.
 - b) Install plumbing fixtures as specified in Section 15410, Plumbing Fixtures.
- 3) Equipment:
 - a) Provide cold water and hot water supply piping as indicated, but not smaller than equipment connections.
 - b) Provide a shutoff valve and union for each connection.
 - c) Provide flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

G. Systems Integration:

- 1. Rough-in domestic water piping for the water-meter installation according to the utility company's requirements.

3.04 REPAIR/RESTORATION

- A. Repair leaks and defects with new materials, and retest the repaired piping or a portion thereof until satisfactory results are obtained.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:

a. Leak Test:

1) Test Procedure:

- a) Test domestic water piping for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - (1) If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - (2) Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved.
 - (3) Expose work that was covered or concealed before it was tested.



- b) Fill domestic water piping with water.
 - (1) Check the components to determine that they are not air bound and that the piping is full of water.
 - c) Cap and subject the piping to a static water pressure of 50 psig (345 kPa) above the operating pressure, without exceeding the pressure rating of the piping system materials.
 - d) Isolate the test source, and allow it to stand for 4 hours.
 - e) Prepare Leak Test Reports, and describe corrective action required to repair any leaks discovered.
 - (1) Submit the Leak Test Reports to the Program/Project Manager for information.
 - 2) Acceptance Criteria:
 - a) Visible leaks and/or loss in test pressure constitute defects that must be repaired.
2. Inspections:
- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by the Authorities Having Jurisdiction.
 - b. During installation of domestic water piping, notify the Authorities Having Jurisdiction at least 24 hours before required inspections must be made.
 - 1) Perform the inspections in the presence of the Authorities Having Jurisdiction.
 - c. Roughing-in Inspection:
 - 1) After the roughing-in of the piping takes place but before the fixtures are set, arrange for an inspection of the piping before it is concealed or closed-in.
 - d. Final Inspection:
 - 1) Arrange a final inspection for the Authorities Having Jurisdiction to observe the tests specified, and to ensure compliance with the specified requirements.
 - e. Inspection Reports:
 - 1) Prepare inspection reports, have them signed by the Authorities Having Jurisdiction, and submit them to the Program/Project Manager for information.
 - f. As-Built Documents:
 - 1) Prepare as-built drawings of the domestic water system, and submit them to the Program/Project Manager for information.

B. Non-Conforming Work

- 1. If the Authorities Having Jurisdiction determine that the piping does not pass the testing or inspections, make the required corrections and arrange for a re-inspection.



3.06 SYSTEM STARTUP

- A. Disinfection:
 - 1. Clean and disinfect potable domestic water piping using purging and disinfecting procedures prescribed by the Authorities Having Jurisdiction.
 - a. Submit water samples in sterile bottles to the Authorities Having Jurisdiction.
 - b. Repeat procedures if biological examination shows contamination.
 - c. Prepare and submit reports of purging and disinfecting activities.
- B. Commissioning:
 - 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.07 CLEANING

- A. Waste Management:
 - 1. Properly and legally dispose of excess disinfection chemicals.
 - 2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15145

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for the following plumbing specialties:
 - a. Backflow preventers.
 - b. Balancing valves.
 - c. Wheel-handle wall hydrants.
 - d. Trap seal primer valves.
 - e. Drain valves.
 - f. Cleanouts.
 - g. Floor drains.
 - h. Roof drains.
 - i. Miscellaneous piping specialties.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01732 - Cutting and Patching.
4. Section 01780 - Closeout Submittals.
5. Section 01810 – Commissioning.
6. Section 02316 - Trenching and Backfilling.
7. Section 07620 - Sheet Metal Flashing and Trim.
8. Section 15050 - Basic Mechanical Materials and Methods.
9. Section 15110 - Valves.
10. Section 15128 - Meters and Gages.
11. Section 15140 - Domestic Water Piping.
12. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. AC: Alternating electric current.
2. CWP: Cold working pressure.
3. FDA: Federal Department of Agriculture.
4. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
5. OS&Y: Outside screw and yoke.



6. PVBA: Pressure vacuum breaker assembly.

B. Definitions:

1. For the electrical Work associated with the domestic water piping specialties provided under this Section, standard terminology defined in NFPA 70 applies.
2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. American Society of Civil Engineers (ASCE):
 - a. ASCE / SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME):
 - a. ASME A112.1.2 - Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors).
 - b. ANSI/ASTM A112.6.3 - Floor and Trench Drains.
 - c. ASME A112.6.4 – Roof, Deck, and Balcony Drains.
 - d. ASME A112.18.1/CSA B125.1 - Plumbing Supply Fittings.
 - e. ASME A112.21.2M – Roof Drains.
 - f. ASME A112.21.3M - Hydrants for Utility and Maintenance Use.
 - g. ASME A112.36.2M – Cleanouts.
 - h. ASME B1.20.7 - Hose Coupling Screw Threads, Inch.
 - i. ASME B31.9 - Building Services Piping.
3. American Society of Sanitary Engineers (ASSE):
 - a. ANSI/ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
 - b. ANSI/ASSE 1010 - Performance Requirements for Water Hammer Arresters.
 - c. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
 - d. ANSI/ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
 - e. ANSI/ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
 - f. ANSI/ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.
 - g. ANSI/ASSE 1018 - Trap Seal Primer Valves - Potable Water Supplied.
 - h. ANSI/ASSE 1020 - Pressure Vacuum Breakers Assembly.



- i. ANSI/ASSE 1024 - Dual Check Valve Type Backflow Preventers.
 - j. ANSI/ASSE 1047 - Performance Requirements for Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies.
 - k. ANSI/ASSE 1048 - Performance Requirements for Double Check Detector Fire Protection Backflow Prevention Assemblies.
 - l. ANSI/ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers.
 - m. ANSI/ASSE 1056 – Back Siphonage Backflow Vacuum Breakers.
4. American Water Works Association (AWWA):
 - a. AWWA C550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
5. ASTM International (ASTM):
 - a. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 - b. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
 - c. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
 - d. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
6. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
7. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
8. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
9. Manufacturers Standardization Society (MSS):
 - a. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
 - b. MSS SP-110 - Ball Valves Treaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
10. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
11. NSF International (NSF):
 - a. NSF/ANSI 61 - Drinking Water System Components - Health Effects.
12. The Plumbing and Drainage Institute (PDI):
 - a. PDI-WH 201 - Water Hammer Arresters.
13. Underwriters Laboratories, Inc. (UL):
 - a. UL 486A-486B - Wire Connectors.
 - b. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordination Drawings:

- a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.
 - 2) Include power, signal, and control wiring diagrams.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Product Data:
 - 1) Hose bibs.
 - 2) Open drains.
 - 3) Fixed air-gap fittings.
 - 4) Stack flashing fittings.
 - 5) Vent terminals.
 - 6) Floor and trench drains.
 - 7) Piping joining materials.
- b. Shop Drawings:
 - 1) Coordination Drawings.
- c. Certificates:
 - 1) Electrical Listing and Labeling.
- d. Special Procedure Submittals:
 - 1) Field Test Reports of purging and disinfecting activities.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Vent flashing sleeve manufacturer's written installation instructions.
 - 2) Roof drain manufacturer's written installation instructions.



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:
 - 1) Backflow preventer maintenance contracts.
 - 2) Trap seal primer valves and system maintenance contracts.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Piping Material Certification:
 - a. Provide plumbing specialties that bear the label, stamp, or other markings of the testing agency specified.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport domestic water piping specialties in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 - 1. Store and handle domestic water piping specialties in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 DOMESTIC WATER PIPING SPECIALTIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. NSF International (NSF) Compliance:
 - 1) For potable domestic water plumbing specialties, comply with the requirements specified in Sections 1 through 9 of NSF/ANSI 61.
- C. Performance:
 - 1. Seismic Performance:



- a. Provide soil, waste, and vent piping and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.

D. Design Criteria

1. Piping Systems:

- a. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - 1) Plans, schematics, and diagrams included in the Contract Drawings indicate the sizes, profiles, and/or dimensional requirements of the plumbing specialties based on the specific system indicated.
 - 2) The indicated locations and arrangements may need to be modified based on the specific system provided and other design considerations.
 - 3) Install domestic water piping specialties as indicated unless deviations to the installation are approved by the Program/Project Manager on Coordination Drawings.
- b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a domestic water piping system with a 125 psig minimum working pressure rating:
- c. Piping Materials and Installation:
 - 1) Comply with the requirements for piping materials and installation specified in ASME B31.9.

2. Product Data:

- a. Prepare Product Data for the domestic water piping system components to be provided under this Section, including the rated capacities and shipping, installed, and operating weights of system components.
 - 1) Indicate the materials, finishes, dimensions, required clearances, and methods of assembly of the components; and the piping and wiring connections for the following:
 - a) Drain valves and hose bibbs.
 - b) Floor drains.
 - c) Vent caps, vent terminals, and roof flashing assemblies.
- b. Submit the Product Data for the domestic water piping system to the Program/Project Manager for approval.

E. Materials:

1. Drain Valves:

- a. Hose-End Drain Valves:



- 1) Provide 3/4-inch nominal pipe size ball valves complying with the requirements specified in MSS SP-110, and rated for 400 psig minimum cold working pressure (CWP).
 - a) Provide a two-piece, copper-alloy body with a standard port, a chrome-plated brass ball, replaceable seats and seals, a blowout-proof stem, and a vinyl-covered steel handle for each valve.
 - b) Inlet:
 - (1) Provide a threaded or solder joint inlet.
 - c) Outlet:
 - (1) Provide a short-threaded nipple having garden-hose threads complying with the requirements specified in ASME B1.20.7 and a cap.
- b. Hose-End Drain Valves:
 - 1) Provide Class 125 gate valves complying with the requirements specified in MSS SP-80, and having a bronze body complying with the requirements specified in ASTM B 62.
 - a) Inlet:
 - (1) Provide a 3/4-inch nominal pipe size threaded or solder joint inlet.
 - b) Outlet:
 - (1) Provide an outlet having garden-hose threads complying with the requirements specified in ASME B1.20.7 and a cap.
 - 2) Hose bibbs are unacceptable for this application.
- c. Hose Bibbs:
 - 1) Provide bronze body hose bibbs having a replaceable seat disc complying with the requirements specified in ASME A112.18.1/CSA B125.1 for compression-type faucets.
 - a) Provide either a 1/2-inch or a 3/4-inch nominal pipe size threaded or solder-joint inlet designed for a pressure of at least 125 psig.
 - b) Provide an integral non-removable, drainable hose-connection vacuum breaker having garden-hose threads complying with the requirements specified in ASME B1.20.7 on the outlet.
 - 2) Finishes:
 - a) For equipment rooms, provide hose bibbs having a rough bronze, chrome, or nickel plated finish.
 - b) For service areas, provide hose bibbs having a chrome or nickel plated finish.



- c) For finished rooms, provide hose bibbs having a chrome or nickel plated finish.
- 3) Provide an integral wall flange with each chrome- or nickel-plated hose bibb.
- d. Floor-Drain Inlet Fittings:
 - 1) Provide cast iron floor-drain inlet fittings having a threaded inlet and a threaded or spigot outlet and a trap seal primer valve connection.
- e. Fixed Air-Gap Fittings:
 - 1) Provide manufactured cast-iron or bronze fixed air-gap drainage fittings with a semi-open top having threads or a device to secure the drainage inlet piping in the top, and a bottom spigot or threaded outlet larger than the top inlet.
 - 2) Provide a design complying with the requirements specified in ASME A112.1.2 that ensures a fixed air gap between the installed inlet and outlet piping.
- f. Stack Flashing Fittings:
 - 1) Provide counterflashing-type, cast-iron stack flashing fittings having a bottom recess for terminating the roof membrane, and a threaded or hub top for extending the vent pipe.
- g. Vent Terminals:
 - 1) Provide commercially manufactured vent terminals, shop-fabricated or field-fabricated, constructed from galvanized steel, copper, or lead-coated copper.
 - 2) Provide a frost-proof assembly, sized to provide a 1-inch enclosed air space between the outside of the pipe and the inside of the flashing collar extension, and having counterflashing.
- h. Cleanouts:
 - 1) Floor and Wall Cleanouts:
 - a) Provide cleanouts complying with the requirements specified in ASME A112.36.2M.
 - b) Body or Ferrule and Housing:
 - (1) Provide floor cleanouts having a cast-iron body or ferrule having a threaded outlet connection, and a cast-iron adjustable housing.
 - c) Closure:
 - (1) Provide a brass closure plug having straight threads, a gasket, and a clamping device.
 - d) Frame and Cover:
 - (1) Provide a round nickel-bronze, copper alloy frame and cover.



- 2) Manufacturers:
 - (1) Josam Company, www.josam.com
 - (2) Sioux Chief Manufacturing Co., Inc., <http://www.siuoxchief.com>.
 - (3) Smith, Jay R. Mfg. Co., www.jrsmith.com
 - (4) Tyler Pipe; Wade Div., www.tylerpipe.com
 - (5) Watts Drainage Products Inc., www.watts.com
 - (6) Zurn Plumbing Products Group., www.zurn.com
 - (7) Approved equal.
- i. Floor and Trench Drains:
 - 1) Provide floor and trench drains complying with the requirements specified in ANSI/ASTM A112.6.3, and having a gray iron body with a round top and a bottom outlet, a cast iron trap, a clamping device, and a seepage flange.
 - a) An inlet fitting, sediment bucket, and lining for exposed surfaces and interior are not required.
 - 2) Finish:
 - a) For the top of the drain body and the strainer, provide a nickel bronze finish.
 - 3) Manufacturers:
 - a) Josam Company, www.josam.com
 - b) Sioux Chief Manufacturing Co., Inc., <http://www.siuoxchief.com>.
 - c) Smith, Jay R. Mfg. Co., www.jrsmith.com
 - d) Tyler Pipe; Wade Div., www.tylerpipe.com
 - e) Watts Drainage Products Inc., www.watts.com
 - f) Zurn Industries, Inc., Jonespec Div., <http://www.zurn.com/products/finish-plumbing>.
 - g) *Zurn Industries, Inc., Specification Drainage Operation*, www.zurn.com/media-library/web_documents/.../floordrains/fd-combined-pdf.aspx
 - h) Approved equal.

2.02 ACCESSORIES

- A. Flashing:
 1. Provide flashing complying with the requirements specified in Section 07620, Sheet Metal Flashing and Trim.
 - a. Fabricate flashing from a single piece, unless large pans, sumps, or other drainage shapes are required.
 - b. Fabricate flashing, and required pans, sumps, and other drainage shapes.



2. Pipe Flashing:
 - a. Provide sleeve type pipe flashing matching the pipe size, and having a minimum length of 10 inches and a skirt or flange extending at least 8 inches around the pipe.
 3. Sleeve Flashing:
 - a. Provide flat sheet sleeve flashing having a skirt or flange extending at least 8 inches around the sleeve.
 4. Embedded Specialty Flashing:
 - a. Provide flat sheet embedded specialty flashing having a skirt or flange extending at least 8 inches around the specialty.
- B. General-Duty Valves:
1. Provide general-duty ball, butterfly, check, gate, and globe valves complying with the requirements specified in Section 15110, Valves.
- C. Meters and Gages
1. Provide meters and gages complying with the requirements specified in Section 15128, Meters and Gages.
- D. Piping Joining Materials:
1. Provide piping joining materials complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Examine the elements and surfaces to receive domestic water piping specialties for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect adjacent areas from damage resulting from installation of the domestic water piping specialties.
- B. Surface Preparation:



1. Perform excavating, trenching, and backfilling operations for domestic water piping in accordance with the requirements specified in Section 02316, Trenching and Backfilling.

C. Demolition/Removal:

1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

A. Basic Domestic Water Piping Specialty Installation Requirements:

1. For wall-hanging plumbing specialties having supports specified, attach the supports to the building substrate and fasten the wall-hanging plumbing specialties securely to the supports.
2. For wall-hanging plumbing specialties having no supports specified, fasten the plumbing specialties directly to the building wall construction.
3. Fasten recessed-type plumbing specialties to reinforcement built into walls.
4. For piping adjacent to equipment, install the piping to allow access for service and maintenance.
5. Pressure Regulators:
 - a. Provide inlet and outlet shutoff valves and a balance valve bypass for pressure regulators, and provide pressure gages on both the pressure regulator inlet and outlet.
6. Strainers:
 - a. Provide strainers on the supply side of each control valve, pressure regulator, and solenoid valve.
7. Expansion Joints:
 - a. Provide expansion joints on vertical risers, stacks, and conductors if indicated in the Contract Documents.
8. Traps:
 - a. Provide traps on plumbing specialty drain outlets.
 - b. Omit traps on indirect waste drains unless a trap is indicated in the Contract Documents.
9. Escutcheons:
 - a. In exposed finished locations and within cabinets and millwork, provide escutcheons complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods, at wall, floor, and ceiling penetrations.
 - b. If required to conceal protruding pipe fittings, provide deep-pattern escutcheons.



B. Cleanouts:

1. Provide a cleanout at each change in the direction of piping greater than 45 degrees, and at the base of each vertical soil and waste stack.
2. For piping up to 4-inch nominal pipe size, provide a cleanout at intervals not greater than 50 feet apart.
3. For piping larger than 4-inch nominal pipe size, provide a cleanout at intervals not greater than 100 feet apart.
4. Unless otherwise indicated in the Contract Documents, install cleanouts in aboveground piping and building drain piping as follows:
 - a. For drainage piping up to 4-inch nominal pipe size, provide cleanouts the same size as the drainage piping.
 - b. For drainage piping larger than 4-inch nominal pipe size, provide 4-inch nominal pipe size cleanouts unless a larger cleanout is indicated in the Contract Documents.
5. For floor cleanouts associated with piping installed below floors, provide cleanout deck plates installed so their top is flush with finished floor.
6. For cleanouts located in concealed piping, provide cleanout wall access covers of the types indicated in the Contract Documents installed so their frames and covers are flush with the finished wall.

C. Vents:

1. Provide air vents at piping high points.
2. For each vent pipe passing through the roof, provide frost-proof vent caps.
 - a. Maintain a 1-inch clearance between the vent pipe and the roof substrate.

D. Floor Drains:

1. At the low points of surface areas to be drained, provide floor drains.
 - a. Unless otherwise indicated in the Contract Documents, set the floor drain grates flush with finished floor.
2. Position floor drains for easy access and maintenance.
3. Provide a floor-drain flashing collar or flange installed so no leakage occurs between the drain and the adjoining flooring.
 - a. Maintain the integrity of waterproof membranes if they are penetrated.
4. Unless otherwise indicated in the Contract Documents, provide individual traps for floor drains connected to the sanitary building drain.

E. Valves:

1. In each water supply to plumbing specialties, provide an individual shutoff valve.
 - a. Install the shutoff valves in accessible locations.



2. If a specific type of valve is not indicated in the Contract Documents, provide a ball, gate, or globe valve.

F. Special Techniques:

1. Flashing:

- a. For pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane, provide sheet flashing.
 - 1) Set flashing installed on floors and roofs in a solid coating of bituminous cement.
 - 2) Secure flashing into sleeves and specialty clamping rings or devices.
- b. For piping passing through roofs, provide flashing having counterflashing or commercially made flashing fittings complying with the requirements specified in Section 07620, Sheet Metal Flashing and Trim.
 - 1) For vent pipes passing through roofs, extend the flashing up the vent pipe and turn it down into the pipe, or secure the flashing into cast-iron sleeves having a calking recess.
- c. Provide flashing and pans, sumps, and other drainage shapes.

2. Electrical Work:

- a. Connect plumbing specialties and devices that require power in accordance with the electrical requirements specified in other appropriate Sections.
- b. Electrically ground equipment.
- c. Tighten electrical connectors and terminals according to the manufacturer's published torque-tightening values.
 - 1) If the manufacturer's torque values are not furnished, use those specified in UL 486A-486B.

G. Interface with Other Work:

1. Piping System Connections:

- a. Connect the domestic water piping specialties to the piping specified under other Sections as indicated in the Contract Documents.
- b. Comply with the requirements specified in Section 15050, Basic Mechanical Materials and Methods, for pipe joining materials, joint construction, and other basic mechanical installation requirements.
 - 1) Additional piping installation requirements are specified in other Sections.

3.04 SYSTEM STARTUP

A. Disinfection:



1. Clean and disinfect potable domestic water piping specialties using the purging and disinfecting procedures prescribed in Section 15140, Domestic Water Piping, and by the Authorities Having Jurisdiction.
 - a. Submit water samples in sterile bottles to the Authorities Having Jurisdiction.
 - b. Repeat procedures if biological examination shows contamination.
 - c. Prepare and submit Field Test Reports of purging and disinfecting activities.

B. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.05 ADJUSTING

- A. Adjust trap seal primer valves so they furnish the proper flow.

3.06 CLEANING

A. Waste Management:

1. Properly and legally dispose of excess disinfection chemicals.
2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect installed drains during the remainder of the construction period to avoid clogging the drains with dirt or debris, and to prevent damage to the drains from traffic or other construction work.
- B. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

3.08 MAINTENANCE

A. Maintenance Contracts:

1. Furnish maintenance contracts for the following domestic water plumbing specialties for insertion in maintenance manuals:
 - a. Backflow preventers.
 - b. Trap seal primer valves and systems.



2. Submit the maintenance contracts to the Program/Project Manager.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15150

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for soil and waste sanitary drainage and vent piping inside buildings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 02531 - Wastewater System.
 - 7. Section 15050 - Basic Mechanical Materials and Methods.
 - 8. Section 15060 - Hangers and Supports.
 - 9. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 10. Section 15155 - Sanitary Waste Piping Specialties.
 - 11. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 2. ASTM International (ASTM):
 - a. ASTM A 167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.



- b. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
- c. ASTM A 888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- d. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- e. ASTM C 1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
- f. ASTM C 1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- 3. Cast Iron Soil Pipe Institute (CISPI):
 - a. CISPI Cast Iron Soil Pipe and Fittings Handbook.
 - b. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 - c. CISPI 310 - Standard Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 6. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.
 - b. MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Test and Inspection Coordination:
 - a. Coordinate with the Program/Project Manager and the Authorities Having Jurisdiction to insure they have been notified sufficiently early to allow ample time for them to schedule and perform the testing and inspections required by them prior to incorporating items requiring testing or inspection into the Work.
 - 1) During installation, notify the Authorities Having Jurisdiction at least 24 hours before tests and inspections must be made.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cast-iron pipe and fittings.
 - 2) Couplings.
 - b. Shop Drawings:
 - 1) Soil, waste, and vent piping system.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Gasket manufacturer's written instructions for the use of lubricants, cements, and other installation requirements
 - b. Site Quality Control Submittals:
 - 1) Code compliance test reports.
 - 2) Inspection reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built drawings of the drainage and vent piping system.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Certifications:

1. Piping Material Certification:
 - a. Provide piping materials that bear the label, stamp, or other markings of the testing agency specified.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 - 1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
 - 2. Protect pipe from impact shocks and free fall during handling.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 SANITARY WASTE AND VENT PIPING COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with requirements, provide products by one of the manufacturers listed.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Seismic Performance:
 - a. Provide soil, waste, and vent piping and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.



D. Design Criteria:

1. Piping System:

- a. Plans, schematics, and diagrams included in the Contract Drawings indicate the general location and arrangement of piping systems.
 - 1) The indicated locations and arrangements were used to size pipe calculate friction losses, and for compliance with other design considerations.
 - 2) Install piping as indicated unless deviations to the layout are approved by the Program/Project Manager on Coordination Drawings.
- b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a sanitary waste and vent piping system with a 10-foot head of water minimum working pressure rating:
- c. Piping Applications:
 - 1) For soil, waste, and vent piping used for both aboveground and underground applications, provide the following piping materials in each size range indicated:
 - a) For pipes having nominal pipe sizes of 1-1/4-inch NPS (DN 32) and 1-1/2-inch NPS (DN 40), provide 1-1/2-inch NPS (DN 40), hubless, cast-iron soil piping, and one of the following:
 - (1) Heavy-duty couplings.
 - (2) Compact couplings.
 - b) For pipes having nominal pipe sizes of 2-inch NPS (DN 50) and 4-inch NPS (DN 100), provide hubless, cast-iron soil piping, and one of the following:
 - (1) Heavy-duty couplings.
 - (2) Compact couplings.
 - c) For underground non-pressure piping, provide flexible transition couplings.

2. Product Data:

- a. Submit Product Data for the products proposed for the Work of this Section to the Program/Project Manager for approval.

3. Shop Drawings:

- a. Submit Shop Drawings of the soil, waste, and vent piping system, to the Program/Project Manager for approval.
 - 1) Include plans and details.

E. Materials:

1. Cast-Iron Pipe and Fittings:

- a. Pipe:



- 1) Provide hubless cast-iron pipe and fittings complying with the requirements specified in ASTM A 888 or CISPI 301.
- b. Couplings:
 - 1) Provide couplings complying with the requirements specified in ASTM C 1277; and consisting of an assembly of a metal housing, corrosion-resistant fasteners, and rubber sleeve with an integral, center pipe stop.
 - a) Rubber Sleeves:
 - (1) Provide rubber sleeves complying with the requirements specified in ASTM C 564.
 - 2) Heavy-Duty Couplings:
 - a) Provide heavy-duty couplings consisting of a stainless-steel shield, stainless-steel bands, and a sleeve.
 - (1) Fabricate the heavy-duty couplings from Type 304 stainless-steel complying with the requirements specified in ASTM A 666.
 - (2) For pipes having nominal pipe sizes from 1-1/2 inches (DN 40) to 4 inches (DN 100), provide heavy-duty couplings having a 3-inch- wide shield with 4 bands.
 - (3) For pipes having nominal pipe sizes from 5 inches to 10 inches, provide heavy-duty couplings having a 4-inch- wide shield with 6 bands.
 - 3) Compact Couplings:
 - a) Provide compact couplings complying with the requirements specified in ASTM A 167 or CISPI 310, and consisting of a stainless-steel corrugated shield, stainless-steel bands, and a sleeve.
 - (1) Fabricate the compact couplings from Type 301 stainless-steel complying with the requirements specified in ASTM A 666.
 - (2) For pipes having nominal pipe sizes from 1-1/2 inches (DN 40) to 4 inches (DN 100), provide compact couplings having a 2-1/8-inch- wide shield with 2 bands.
 - 4) Flexible Transition Couplings:
 - a) Provide flexible transition couplings complying with the requirements specified in ASTM C 1173, and having an elastomeric sleeve.
 - (1) Include ends of the same sizes as the piping to be joined, and include a corrosion-resistant metal band on each end.



2.02 ACCESSORIES

- A. Pipe Hanger and Supports:
 - 1. Provide pipe hangers and support devices complying with the requirements specified in Section 15060, Hangers and Supports.
- B. Seismic-Restraint Devices:
 - 1. Provide seismic-restraint devices as specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- C. Sanitary Waste Piping Specialties:
 - 1. Provide sanitary waste piping specialties as specified in Section 15155, Sanitary Waste Piping Specialties.
- D. Wall Penetration Systems:
 - 1. Provide wall penetration systems complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the sanitary waste and vent system.
- B. Surface Preparation:
 - 1. Perform excavating, trenching, and backfilling operations for sanitary waste piping in accordance with the requirements specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.02 INSTALLATION

- A. Hangers and Supports:
 - 1. Install hangers and supports for the piping in accordance with the requirements specified in Section 15060 - Hangers and Supports, and the following:
 - a. Vertical Piping:
 - 1) Support vertical piping and tubing at the base and at each floor.



- 2) Provide extension pipe or riser clamps (MSS SP-58 Type 8) or carbon or alloy steel riser clamps (MSS SP-58 Type 42).
 - b. Individual Horizontal Piping Runs:
 - 1) For individual straight piping runs 100 feet and less, provide adjustable, steel clevis hangers (MSS SP-58 Type 1).
 - 2) For individual straight piping runs longer than 100 feet, provide adjustable roller hangers (MSS SP-58 Type 43).
 - c. Multiple Horizontal Piping Runs:
 - 1) For multiple straight piping runs 100 feet and longer, provide complete pipe rolls (MSS SP-58 Type 44).
 - 2) Support the pipe rolls on a trapeze.
2. For double-rod hangers, the rod diameter may be reduced 1 size down to a minimum of 3/8 inch (10 mm).
3. Install seismic restraints on piping in accordance with the requirements specified in Section 15071, Vibration and Seismic Controls for Mechanical Systems.
4. Maximum Hanger Spans:
 - a. For vertical cast-iron soil piping, provide supports spaced every 15 feet (4.57m).
 - b. For horizontal cast-iron soil piping, install hangers with the maximum horizontal spacing and minimum rod diameters specified in Table 15150-1.

Table 15150-1 Maximum Horizontal Hanger Spacing and Minimum Rod Diameters		
Nominal Pipe Size(s)	Maximum Horizontal Hanger Spacing ⁽¹⁾	Minimum Rod Diameter
NPS 1-1/2 and NPS 2 (DN 40 and DN 50)	60 inches (1.5m)	3/8 inch (10mm)
NPS 3 (DN 80)	60 inches (1.5m)	1/2 inch (13mm)
NPS 4 (DN 100)	60 inches (1.5m)	5/8 inch (16mm)

5. Support piping and tubing not listed herein according to the requirements specified in MSS SP-69 and the manufacturer's written instructions.

B. Piping:

1. Install cast-iron soil piping in accordance with Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings", in the CISPI Cast Iron Soil Pipe and



Fittings Handbook and the requirements specified in Section 15050, Basic Mechanical Materials and Methods

- a. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1) If the change in the direction of flow is from horizontal to vertical on vertical stacks, sanitary tees and short-sweep 1/4 bends may be provided.
 - 2) If 2 fixtures are installed back to back or side by side with a common drain pipe, provide long-turn, double Y-branch and 1/8-bend fittings.
 - 3) On vent lines, straight tees, elbows, and crosses may be provided.
 - 4) Do not change the direction of flow more than 90 degrees.
 - 5) Use the proper sizes of standard increasers and reducers if pipes of different sizes are connected.
 - 6) Reducing the size of drainage piping in the direction of flow is prohibited.
2. Soil and Waste Drainage and Vent Piping Slopes:
 - a. Unless otherwise indicated, provide soil and waste drainage and vent piping at the following minimum slopes:
 - 1) Building Sanitary Drain:
 - a) For piping NPS 3 and smaller, slope sanitary drainage piping 2 percent downward in the direction of flow.
 - b) For piping NPS 4 and larger; slope sanitary drainage piping 1 percent downward in the direction of flow.
 - 2) Horizontal Sanitary Drainage Piping:
 - a) Slope sanitary drainage piping 2 percent downward in the direction of flow.
 - 3) Vent Piping:
 - a) Slope vent piping 1 percent downward in the direction of a vertical fixture vent or toward a vent stack.
3. Buried Building Soil and Waste Drainage and Vent Piping:
 - a. Install buried building sanitary piping true to the grades and alignment indicated on the Contract Drawings, with unbroken continuity of the invert.
 - b. Lay buried building sanitary drainage piping beginning at the low point of each system.
 - c. Place the hub ends of the piping upstream.
 - d. Install required gaskets according to the manufacturer's written instructions for the use of lubricants, cements, and other installation requirements.



- 1) Submit the gasket manufacturer's written instructions for the use of lubricants, cements, and other installation requirements to the Program/Project Manager for information.
 - e. Maintain a swab in the piping, and pull the swab past each joint as it is completed.
 4. Wall Penetrations:
 - a. Install a wall-penetration fitting system at each service pipe penetration through the foundation wall.
 - 1) Make the wall-penetration fitting system installation watertight.
 - a) Install a cast-iron sleeve having a water stop and a mechanical sleeve seal at each service pipe penetration through foundation wall.
 - b) Select the number of interlocking rubber links required to make the installation watertight.
 - b. Sleeves are not required for cast iron soil piping passing through a concrete slab-on-grade if the slab does not have membrane waterproofing.
 5. Cleanouts:
 - a. Install cleanouts at grade, and extend each cleanout to where the building sanitary drains connect to the building sanitary sewers.
- C. Joints:
1. Comply with the basic requirements for piping joint construction specified in Section 15050, Basic Mechanical Materials and Methods.
 2. Cast Iron Soil Piping Joints:
 - a. For cast iron soil piping, provide joints complying with the requirements specified in Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings" of the CISPI Cast Iron Soil Pipe and Fittings Handbook.
 - b. Hubless Joints:
 - 1) For hubless joints, provide rubber gaskets and sleeves or clamps.
- D. Special Techniques:
1. For piping subject to sewage backflow, provide backwater valves.
 - a. For horizontal piping, provide normally closed type backwater valves unless otherwise indicated in the Contract Documents.
 2. For site sanitary sewer piping, comply with the requirements specified in Section 02531, Wastewater System.
- E. Interface with Other Work:
1. Exterior Sanitary Sewerage Piping:



- a. Connect the soil and waste piping to the Site sanitary sewerage piping exterior to the building.
- b. To join dissimilar piping materials, provide transition fittings.

3.03 REPAIR/RESTORATION

- A. Repair leaks and defects with new materials, and retest the repaired piping or a portion thereof until satisfactory results are obtained.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Perform the tests and inspections specified herein in the presence of the Authorities Having Jurisdiction.
 - 2. Site Tests:
 - a. Code Compliance Test:
 - 1) Test Procedure:
 - a) Test sanitary drainage and vent piping according to the procedures specified by the Authorities Having Jurisdiction.
 - b) Prepare test reports, document corrective actions taken if required, and have the test reports signed by the Authorities Having Jurisdiction.
 - (1) Submit the test reports to the Program/Project Manager for information.
 - 2) Acceptance Criteria:
 - a) Sanitary drainage and vent piping complying with the requirements of the Authorities Having Jurisdiction, as attested to by approval signatures of the Authorities Having Jurisdiction on the test reports, pass the Code Compliance Test.
 - 3. Inspections:
 - 1) During installation, notify the Authorities Having Jurisdiction at least 24 hours before inspections must be made.
 - 2) Do not enclose, cover, or put piping into operation until it is inspected and approved by the Authorities Having Jurisdiction.
 - b. Roughing-in Inspection:
 - 1) Arrange for an inspection of the piping before concealing or closing-in after piping roughing-in and before setting fixtures.
 - c. Final Inspection:
 - 1) Arrange for a final inspection by the Authorities Having Jurisdiction to observe the tests specified herein and to ensure compliance with requirements.



d. Inspection Reports:

- 1) Prepare inspection reports, have them signed by the Authorities Having Jurisdiction, and submit them to the Program/Project Manager for information.

B. Non-Conforming Work

1. If the Authorities Having Jurisdiction find the piping does not pass the tests or inspections, make required corrections and arrange for a re-inspection.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.06 CLEANING

- A. Clean the interior of sanitary waste and vent piping by removing dirt and debris as the Work progresses.
- B. Waste Management:
1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

A. As-Built Documents:

1. Prepare as-built drawings of the drainage and vent piping system, and submit them to the Program/Project Manager for information.

3.08 PROTECTION

- A. At the end of each workday and whenever the sanitary waste and vent piping Work stops, place plugs in the ends of uncompleted piping to prevent dirt and debris from entering the piping.
- B. Protect installed drains during the remainder of the construction period to prevent the drains from becoming clogged with dirt and debris, and to prevent damage from traffic and construction work.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15155

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following sanitary waste piping specialties:
 - a. Cleanouts.
 - b. Floor drains.
 - c. Roof flashing assemblies.
 - d. Miscellaneous sanitary drainage piping specialties.
 - e. Flashing materials.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01732 - Cutting and Patching.
 - 3. Section 01810 – Commissioning.
 - 4. Section 02316 - Trenching and Backfilling.
 - 5. Section 07620 - Sheet Metal Flashing and Trim.
 - 6. Section 15050 - Basic Mechanical Materials and Methods.
 - 7. Section 15150 - Sanitary Waste and Vent Piping.
 - 8. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. ASCE / SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 2. American Society of Mechanical Engineers (ASME):



- a. ASME A112.1.2 - Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors).
 - b. ANSI/ASME A112.6.3 - Floor and Trench Drains.
 - c. ASME A112.36.2M – Cleanouts.
3. ASTM International (ASTM):
 - a. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 - b. ASTM B 32 - Standard Specification for Solder Metal.
 - c. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. The Society for Protective Coatings (SSPC):
 - a. SSPC-Paint 33 – Coal Tar Mastic, Cold Applied.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cleanouts
 - 2) Floor Drains
 - 3) Roof Flashing Assemblies
 - 4) Miscellaneous Sanitary Drainage Piping Specialties
 - 5) Flashing Materials



- b. Shop Drawings:
 - 1) Coordination Drawings.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Certifications:
 - 1. Piping Material Certification:
 - a. Provide piping specialties that bear the label, stamp, or other markings of the testing agency specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport sanitary waste piping specialties in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 - 1. Store and handle sanitary waste piping specialties in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 SANITARY WASTE PIPING SPECIALTIES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
 - 2. Substitution Limitations:



- a. Subject to compliance with requirements, provide products by one of the manufacturers listed.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Seismic Performance:
 - a. Provide sanitary waste piping specialties and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.
- D. Design Criteria:
 - 1. Piping System:
 - a. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - 1) Plans, schematics, and diagrams included in the Contract Drawings indicate the sizes, profiles, and/or dimensional requirements of the plumbing specialties based on the specific system indicated.
 - 2) The indicated locations and arrangements may need to be modified based on the specific system provided and other design considerations.
 - 3) Install sanitary waste piping specialties as indicated unless deviations to the installation are approved by the Program/Project Manager on the Coordination Drawings.
 - b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a sanitary waste and vent piping system with a 10-foot head of water minimum working pressure rating:
 - 2. Floor Cleanout Top Loading Classification:
 - a. In vehicle traffic areas, provide floor cleanouts classified for Extra Heavy Duty top loading.
 - b. In all areas other than vehicle traffic areas, provide floor cleanouts classified for Light Duty top loading.
 - 3. Product Data:



- a. Prepare Product Data, including the rated capacities, operating characteristics, and accessories for grease interceptors, for the following products:
 - 1) Cleanouts.
 - 2) Floor drains.
 - 3) Roof flashing assemblies.
 - 4) Miscellaneous sanitary drainage piping specialties.
 - 5) Flashing materials.
 - b. Submit the Product Data to the Program/Project Manager for approval:
- E. Materials:
- 1. Cleanouts:
 - a. Exposed Cleanouts:
 - 1) Provide exposed cleanouts complying with the requirements for cast-iron cleanouts for cleanout test tees specified in ASME A112.36.2M, and of the same size as the connected drainage piping.
 - 2) Body:
 - a) Provide hubless, cast-iron soil pipe test tee bodies matching the connected piping.
 - 3) Closure:
 - a) Provide a countersunk, cast-iron closure plug the same size as or not more than one size smaller than the cleanout size.
 - 4) Manufacturers:
 - a) Josam Company, www.josam.com
 - b) MIFAB, Inc., www.mifab.com
 - c) Smith, Jay R. Mfg. Co., www.jrsmith.com
 - d) Tyler Pipe; Wade Div., www.tylerpipe.com
 - e) Watts Drainage Products Inc., www.watts.com
 - f) Zurn Plumbing Products Group., www.zurn.com
 - g) Approved equal.
 - b. Floor Cleanouts:
 - 1) Provide adjustable housing type floor cleanouts complying with the requirements for adjustable housing cleanouts specified in ASME A112.36.2M; and of the same size as the connected drainage branch, except not larger than the 4-inch size.
 - 2) Body or Ferrule and Housing:
 - a) Provide floor cleanouts having a cast-iron body or ferrule having a threaded outlet connection, and a cast-iron adjustable housing.
 - 3) Closure:



- a) Provide a cast-iron closure plug having a clamping device.
- 4) Frame and Cover:
 - a) Provide a round nickel-bronze, copper alloy frame and cover.
- 5) Riser:
 - a) Provide a service class, cast-iron drainage pipe fitting and a riser pipe complying with the requirements specified in ASTM A 74 to the cleanout frame and cover.
- 6) Manufacturers:
 - a) Josam Company, www.josam.com.
 - b) Oatey, www.oatey.com.
 - c) Sioux Chief Manufacturing Company, Inc., www.siouxchief.com.
 - d) Smith, Jay R. Mfg. Co., www.jrsmith.com.
 - e) Tyler Pipe; Wade Div., www.tylerpipe.com.
 - f) Watts Drainage Products Inc., www.watts.com.
 - g) Zurn Plumbing Products Group., www.zurn.com.
 - h) Approved equal.
- c. Wall Cleanouts:
 - 1) Provide cast-iron wall cleanouts complying with the requirements for wall cleanouts specified in ASME A112.36.2M, and of the same size as the connected drainage piping.
 - 2) Body:
 - a) Provide hubless, cast-iron soil pipe test tee bodies matching the connected piping.
 - 3) Closure:
 - a) Provide a countersunk, brass closure plug the same size as or not more than one size smaller than the cleanout size.
 - 4) Wall Access Frame and Cover:
 - a) Provide a round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
 - 5) Manufacturers:
 - a) Josam Company, www.josam.com
 - b) MIFAB, Inc., www.mifab.com
 - c) Smith, Jay R. Mfg. Co., www.jrsmith.com
 - d) Tyler Pipe; Wade Div., www.tylerpipe.com
 - e) Watts Drainage Products Inc., www.watts.com
 - f) Zurn Plumbing Products Group., www.zurn.com
 - g) Approved equal.
- 2. Floor Drains:
 - a. Provide cast-iron floor drains complying with the requirements specified in ASME A112.6.3, and having a floor drain pattern.



- b. Body:
 - 1) Provide bottom outlet gray iron floor drain bodies.
 - 2) Provide a seepage flange, an anchor flange, and a clamping device for each floor drain.
- c. Manufacturers:
 - 1) Commercial Enameling Co., <https://www.cecosinks.com/>.
 - 2) Josam Company, www.josam.com
 - 3) MIFAB, Inc., www.mifab.com
 - 4) Smith, Jay R. Mfg. Co., www.jrsmith.com
 - 5) Tyler Pipe; Wade Div., www.tylerpipe.com
 - 6) Watts Drainage Products Inc., www.watts.com
 - 7) Zurn Plumbing Products Group., www.zurn.com
 - 8) Approved equal.
- 3. Air-Gap Fittings:
 - a. Provide air-gap fittings complying with the requirements specified in ASME A112.1.2, and designed to ensure a fixed, positive air gap between the installed inlet and outlet piping.
 - b. Provide air-gap fittings the same size as the connected waste piping, and having an inlet large enough for the associated indirect waste piping.
 - c. Body:
 - 1) Provide bronze or cast iron air-gap fitting bodies.
 - 2) Provide an inlet opening in the top of the body, and outlet larger than the inlet.
- 4. Sleeve Flashing Devices:
 - a. For pipe floor penetrations of floor membranes, provide manufactured cast-iron fittings having a clamping device that forms a sleeve sized to fit closely to the riser or stack piping.
 - 1) In the top of the fitting, provide a galvanized-steel pipe extension that will extend 2 inches above the finished floor.
 - 2) In the bottom of the fitting, provide a galvanized-steel pipe extension that will extend through the floor slab.
- F. Shop Fabrication:
 - 1. Fabricate sheet flashing from lead sheets.
 - a. Unless large pans, sumps, or other drainage shapes are required, fabricate flashing from a single piece of lead sheet.
 - b. If joining lead sheets is required, join the sheets in accordance with the following criteria:
 - 1) For lead sheets that are 0.0938 inch thick or thicker and that weigh at least 6.0 pounds per square foot, provide burn joints.



- 2) For lead sheets 0.0625 inch thick or thicker and weighing at least 4.0 pounds per square foot, provide solder joints.

2.02 ACCESSORIES

A. Sheet Flashing:

1. Flashing Materials:

- a. Fabricate flashing from lead sheets.
 - b. Lead Sheet:
 - 1) Provide Type L51121, copper bearing lead sheet complying with the requirements specified in ASTM B 749.
 - 2) Unless otherwise indicated in the Contract Documents, provide lead sheet having the following minimum weights and thicknesses for the applications listed:
 - a) General Use:
 - (1) Weight: 4.0 pounds per square foot.
 - (2) Thickness: 0.0625 inch.
 - b) Vent Pipe Flashing:
 - (1) Weight: 3.0 pounds per square foot.
 - (2) Thickness: 0.0469 inch.
 - c) Burning:
 - (1) Weight: 6.0 pounds per square foot.
 - (2) Thickness: 0.0938 inch.
 - c. Fasteners:
 - 1) Provide fasteners made from metal compatible with the material and substrate being fastened.
 - d. Metal Accessories:
 - 1) Provide sheet metal strips, clamps, anchoring devices, and similar accessory units required for installing the sanitary waste piping specialties.
 - 2) Provide metal accessories matching or compatible with the material of the specialties being installed.
 - e. Solder:
 - 1) Provide lead-free alloy solder complying with the requirements specified in ASTM B 32.
 - f. Coatings:
 - 1) Provide solvent-type, bituminous mastic complying with the requirements specified in SSPC-Paint 33.
- #### 2. Pipe Flashing:
- a. Provide sleeve type pipe flashing matching the pipe size, having a minimum length of 10 inches, and having a skirt or flange extending at least 8 inches around the pipe.



3. Sleeve Flashing:
 - a. Provide flat sheet sleeve flashing having a skirt or flange extending at least 8 inches around the sleeve.
4. Embedded Specialty Flashing:
 - a. Provide flat sheet embedded specialty flashing having a skirt or flange extending at least 8 inches around the specialty.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the elements and surfaces to receive sanitary waste piping specialties for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the sanitary waste system.
- B. Surface Preparation:
 1. Perform excavating, trenching, and backfilling operations for sanitary waste piping specialties in accordance with the requirements specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Basic Sanitary Waste Piping Specialty Installation Requirements:
 1. For wall-hanging plumbing specialties having supports specified, attach the supports to the building substrate and fasten the wall-hanging plumbing specialties securely to the supports.
 2. For wall-hanging plumbing specialties having no supports specified, fasten the plumbing specialties directly to the building wall construction.



3. Fasten recessed-type plumbing specialties to reinforcement built into walls.
4. For piping adjacent to equipment, install the piping to allow access for service and maintenance.
5. Traps:
 - a. Unless otherwise indicated in the Contract Documents, provide individual traps for floor drains connected to the sanitary building drain.
 - 1) Provide traps on plumbing specialty drain outlets.
 - 2) Omit traps on indirect wastes unless a trap is indicated in the Contract Documents.
 - b. Backwater valves are not required.
6. Escutcheons:
 - a. In exposed finished locations and within cabinets and millwork, provide escutcheons complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods, at wall, floor, and ceiling penetrations.
 - b. If required to conceal protruding pipe fittings, provide deep-pattern escutcheons.

B. Cleanouts:

1. For aboveground piping and building drain piping, unless otherwise indicated in the Contract Documents provide cleanouts according to the following:
 - a. Size:
 - 1) For drainage piping up to a nominal pipe size of NPS 4, provide cleanouts the same size as the drainage piping.
 - 2) For drainage piping larger than nominal pipe size of NPS 4, provide NPS 4 cleanouts unless a larger cleanout is indicated in the Contract Documents.
 - b. Provide a cleanout at each piping change in direction greater than 45 degrees.
 - c. Cleanouts in Long Piping Runs:
 - 1) For piping having nominal pipe sizes of NPS 4 and smaller, provide cleanouts spaced a maximum of 50 feet apart along the piping run.
 - 2) For piping having nominal pipe sizes larger than NPS 4, provide cleanouts spaced a maximum of 100 feet apart along the piping run.
 - d. Provide a cleanout at the base of each vertical soil and waste stack.
2. For piping below floors, provide floor cleanouts having cleanout deck plates installed flush with the top of the finished floor.



3. For concealed piping, provide cleanouts having wall access covers of the types indicated in the Contract Documents, and install each frame and cover flush with the finished wall.

C. Floor Drains:

1. Provide floor drains at low points of surface areas to be drained.
2. Set the floor drains below the elevation of the surrounding finished floor to allow for floor drainage.
3. Unless otherwise indicated in the Contract Documents, set the grates of the floor drains flush with finished floor.
 - a. Depress the floor slope in the drainage area to the grates in accordance with the following criteria:
 - 1) For drainage radii 30 inches or less, provide a depression producing a floor slope equivalent to 1 percent, but the total depression must not be less than 1/4 inch deep.
 - 2) For drainage radii 30 inches to 60 inches, provide a depression producing a floor slope equivalent to 1 percent.
 - 3) For drainage radii 30 inches or larger, provide a depression producing a floor slope equivalent to 1 percent, but the total depression must not be greater than 1 inch deep.
4. Provide a floor-drain flashing collar or flange so no leakage occurs between the drain and the adjoining flooring.
5. Where waterproof membranes are penetrated by floor drains, maintain the integrity of the waterproof roofing.
6. For floor drains that require a trap-seal primer connection, provide floor-drain trap-seal primer fittings that are the same size as the floor drain inlet unless the trap has trap-seal primer connection.
 - a. Install the floor-drain trap-seal primer fittings on the inlet to floor drains
7. Position floor drains for easy access and maintenance.

D. Air-Gap Fittings:

1. For draining-type backflow preventers and indirect-waste piping discharges into the sanitary drainage system, provide air-gap fittings.

E. Special Techniques:

1. Flashing:
 - a. For pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane, provide sheet flashing.
 - 1) Set flashing installed on floors and roofs in a solid coating of bituminous cement.
 - 2) Secure flashing into sleeves and specialty clamping rings or devices.



- b. For piping passing through roofs, provide flashing having counterflashing or commercially made flashing fittings complying with the requirements specified in Section 07620, Sheet Metal Flashing and Trim.
 - 1) For vent pipes passing through roofs, extend the flashing up the vent pipe and turn it down into the pipe, or secure the flashing into cast-iron sleeves having a calking recess.
 - c. For sanitary stack vents and vent stacks that extend through the roof, provide roof flashing assemblies and flashing fittings.
 - d. For stacks and risers passing through floors with waterproof membrane, provide a sleeve flashing device.
- F. Interface with Other Work:
- 1. Piping System Connections:
 - a. Connect the sanitary waste piping specialties to the piping specified under other Sections as indicated in the Contract Documents.
 - b. Comply with the requirements specified in Section 15050, Basic Mechanical Materials and Methods, for pipe joining materials, joint construction, and other basic mechanical installation requirements.
 - 1) Additional piping installation requirements are specified in other Sections.
- G. Systems Integration:
- 1. Sanitary Waste System:
 - a. Connect the sanitary waste piping specialties provided under this Section to the sanitary waste piping provided under Section 15150, Sanitary Waste and Vent Piping, and test the completed system as specified therein.

3.04 SYSTEM STARTUP

- A. Commissioning:
- 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.05 PROTECTION

- A. Protect installed drains during the remainder of the construction period to avoid clogging the drains with dirt or debris, and to prevent damage to the drains from traffic or other construction work.



- B. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15160

STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following storm drainage piping and fittings within buildings:
 - a. Pipe, tube, and fittings.
 - b. Special pipe fittings.
 - 2. Storm sewer and drainage piping at the Site, but outside the facilities, buildings, or structures is specified in Section 02630, Storm Drainage.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01732 - Cutting and Patching.
 - 3. Section 01810 - Commissioning.
 - 4. Section 02316 - Trenching and Backfilling.
 - 5. Section 02630 - Storm Drainage.
 - 6. Section 15050 - Basic Mechanical Materials and Methods.
 - 7. Section 15060 - Hangers and Supports.
 - 8. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 9. Section 15080 - Mechanical Insulation.
 - 10. Section 15165 – Storm Drainage Piping Specialties.
 - 11. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 2. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
 - 3. PVC: Polyvinyl-chloride.



4. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. American Society of Civil Engineers (ASCE):
 - a. ASCE / SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. American Water Works Association (AWWA):
 - a. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch (76 mm Through 1,219 mm), for Water.
 - b. AWWA C111/A21.11 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - c. AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings, 3 In. (76 mm) Through 64 In. (1,600 mm), for Water Service.
 - d. AWWA C606 – AWWA Standard for Grooved and Shouldered Joints.
3. ASTM International (ASTM):
 - a. ASTM A 888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 - b. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - c. ASTM C 1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
 - d. ASTM C 1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - e. ASTM C 1460 - Standard Specification for Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground.
 - f. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
 - g. ASTM D 3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.



- h. ASTM D 5926 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
 - i. ASTM F 477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - j. ASTM F 891 – Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core.
- 4. Cast Iron Soil Pipe Institute (CISPI):
 - a. CISPI Cast Iron Soil Pipe and Fittings Handbook.
 - b. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 - c. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.
 - b. MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.
- 8. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 9. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.
- 10. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Test and Inspection Coordination:
 - a. Coordinate with the Program/Project Manager and the Authorities Having Jurisdiction to insure they have been notified sufficiently early to allow ample time for them to schedule and perform the testing and



inspections required by them prior to incorporating items requiring testing or inspection into the Work.

- 1) During installation, notify the Authorities Having Jurisdiction at least 24 hours before tests and inspections must be made.
2. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Hubless cast iron soil pipe and fittings.
 - 2) Standard, shielded, stainless steel couplings.
 - 3) Flexible non-pressure pipe couplings.
 - 4) Shielded non-pressure pipe couplings.
 - 5) Wall-penetration fittings.
 - b. Shop Drawings:
 - 1) Controlled- flow storm drainage system.
 - 2) Coordination Drawings.
 - c. Delegated Design Submittals:
 - 1) Calculations for the controlled-flow storm drainage system.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Site Quality Control Submittals:
 - 1) Leak test reports.
 - 2) Inspection reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:



- 1) As-built drawings of the storm drainage system.
- b. Sustainable Design Closeout Documentation:
 - 1) Low-Emitting Materials: Adhesives & Sealants, Submittal for sealants and sealant primers.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Sustainability Standards Certifications:
 1. Adhesives and Sealants Submittal:
 - a. For the sealants and sealant primers used within the storm drainage system, submit Product Data, including a printed statement of volatile organic compound (VOC) content and chemical components, signed by the product manufacturer certifying that these products qualify the Project to claim Low-Emitting Materials: Adhesives & Sealants, to the Program/Project Manager for information.
 - 1) Certify compliance with SCAQMD Rule 1168.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
 2. Protect pipe from impact shocks and free fall during handling.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



PART 2 PRODUCTS

2.01 STORM DRAINAGE PIPING COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with requirements, provide products by one of the manufacturers listed.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Adhesives:
 - 1) Provide interior adhesives and adhesive primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) PVC Welding: Not more than 510 grams per Liter less water.
 - b) Adhesive Primer for Plastic: Not more than 550 grams per Liter less water.
- C. Performance:
 - 1. Seismic Performance:
 - a. Provide soil, waste, and vent piping and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.
- D. Design Criteria:
 - 1. Piping System:
 - a. Plans, schematics, and diagrams included in the Contract Drawings indicate the general location and arrangement of piping systems.



- 1) The indicated locations and arrangements were used to size pipe calculate friction losses, and for compliance with other design considerations.
 - 2) Install piping as indicated unless deviations to the layout are approved by the Program/Project Manager on Coordination Drawings.
 - b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a storm drainage piping system with a 10-foot head of water minimum working pressure rating.
 - c. Pipe Class:
 - 1) Provide Service class soil pipe and fittings, gaskets, and gasketed joints for all sizes of aboveground and underground storm drainage piping.
 2. Product Data:
 - a. Submit Product Data for each product provided under this Section to the Program/Project Manager for approval.
 3. Shop Drawings:
 - a. Submit Shop Drawings of the controlled-flow storm drainage system, to the Program/Project Manager for approval.
 - 1) Include plans and details.
 4. Calculations:
 - a. Submit calculations for the controlled-flow storm drainage system to the Program/Project Manager for approval.
- E. Materials:
1. Soil Pipe and Fittings:
 - a. Pipe and Fittings:
 - 1) Except for pipe embedded in concrete columns, provide hubless cast iron soil pipe and fittings complying with the requirements specified in ASTM A 888 or CISPI 301.
 - 2) For pipe embedded in concrete columns, provide Schedule 80 polyvinyl-chloride (PVC) pipe and fittings complying with the requirements specified in ASTM D 2665 and ASTM F 891.
 - a) Fittings:
 - (1) Provide socket fittings complying with the requirements specified in ASTM D 2665, and manufactured in drain, waste, and vent patterns to fit Schedule 80 pipe in accordance with the requirements specified in ASTM D 3311.
 - b. Shielded Couplings:

24th St Station Storm
Drainage Sleeve Material





- 1) Provide shielded couplings complying with the requirements specified in ASTM C 1277, and consisting of an assembly of a metal shield or housing, corrosion-resistant fasteners, and a rubber sleeve with an integral, center pipe stop.
 - 2) Standard, Shielded, Stainless-Steel Couplings:
 - a) Provide standard, shielded, stainless steel couplings complying with the requirements specified in CISPI 310, consisting of a stainless steel corrugated shield; stainless-steel bands and tightening devices; and a rubber sleeve complying with the requirements specified in ASTM C 564.
 - b) Manufacturers:
 - (1) ANACO, www.anaco-husky.com/
 - (2) Fernco, Inc., www.fernco.com.
 - (3) Mission Rubber Co., www.missionrubber.com.
 - (4) Tyler Pipe; Soil Pipe Division, www.tylerpipe.com.
 - (5) Approved equal.
2. Special Pipe Fittings:
- a. Flexible Non-Pressure Pipe Couplings:
 - 1) Provide flexible non-pressure pipe couplings complying with the requirements specified in ASTM C 1173, and consisting of elastomeric, sleeve-type, couplings of the reducing or transition pattern and a corrosion-resistant-metal tension band and tightening mechanism on each end.
 - a) Include shear rings.
 - b) Provide ends the same size as the piping to be joined.
 - 2) Sleeve Materials:
 - a) For cast iron soil pipes, provide rubber sleeves complying with the requirements specified in ASTM C 564.
 - 3) Manufacturers:
 - a) Dallas Specialty & Mfg. Co., www.dallasspecialty.com.
 - b) Fernco, Inc., www.fernco.com.
 - c) Mission Rubber Co., www.missionrubber.com.
 - d) NDS, Inc., www.ndspro.com.
 - e) Approved equal.
 - b. Shielded Non-Pressure Pipe Couplings:
 - 1) Provide shielded non-pressure pipe couplings complying with the requirements specified in ASTM C 1460, and consisting of elastomeric or rubber sleeves with a full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 2) Manufacturers:
 - a) Cascade Waterworks Mfg. Co., www.cascademfg.com.



- b) Mission Rubber Co., www.missionrubber.com.
 - c) Approved equal.
- c. Wall-Penetration Fittings:
 - 1) Provide compound, ductile-iron coupling fittings having sleeves and flexing sections designed for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53.
 - a) Include ductile-iron glands, rubber gaskets, and steel bolts complying with the requirements specified in AWWA C111/A21.11.
 - 2) Manufacturers:
 - a) SIGMA Corp., www.sigmaco.com.
 - b) Approved equal.
- d. Transition Couplings:
 - 1) Provide transition couplings consisting of a fitting or device designed for joining piping of different materials or having small differences in diameter.
 - a) Provide end connections the same size as and compatible with the pipes to be joined.
 - 2) Fitting-Type Transition Couplings:
 - a) Provide manufactured pipe couplings, or specified-piping system fittings.
 - 3) Unshielded, Non-Pressure Transition Couplings:
 - a) Provide elastomeric, sleeve-type, reducing or transition pattern couplings complying with the requirements specified in ASTM C 1173, and having a shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - b) Sleeves:
 - (1) For cast-iron soil pipes, provide rubber sleeves complying with the requirements specified in ASTM C 564.
 - (2) For plastic pipes, provide elastomeric seals complying with the requirements specified in ASTM F 477, or polyvinyl-chloride sleeves complying with the requirements specified in ASTM D 5926.
 - (3) For dissimilar pipes, provide polyvinyl-chloride sleeves complying with the requirements specified in ASTM D 5926, or sleeves manufactured from another material compatible with the pipe materials being joined.



2.02 ACCESSORIES

- A. Cleanouts:
 - 1. Provide cleanouts complying with the requirements specified in Section 15165, Storm Drainage Piping Specialties.
- B. Pipe Hangers and Supports:
 - 1. Provide pipe hangers and supports complying with the requirements specified in Section 15060, Hangers and Supports.
- C. Pipe Insulation:
 - 1. Provide rigid insulation complying with the requirements specified in Section 15080, Mechanical Insulation.
 - 2. All storm drain piping, if used for downspouts in columns, wrap with 1" fiberglass.
- D. Seismic-Restraint Devices:
 - 1. Provide seismic-restraint devices complying with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- E. Storm Drainage Piping Specialties:
 - 1. Provide storm drainage piping specialties complying with the requirements specified in Section 15165, Storm Drainage Piping Specialties.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the storm drainage system.
- B. Surface Preparation:
 - 1. Perform excavating, trenching, and backfilling operations for storm drainage piping in accordance with the requirements specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 - 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.



3.02 INSTALLATION

A. Hangers and Supports:

1. Install hangers and supports for piping in accordance with the requirements specified in Section 15060 - Hangers and Supports, and the following:
 - a. Vertical Piping:
 - 1) Support vertical piping and tubing at the base and at each floor.
 - 2) Provide extension pipe or riser clamps (MSS SP-58 Type 8) or carbon or alloy steel riser clamps (MSS SP-58 Type 42).
 - b. Horizontal Individual Piping Runs:
 - 1) For individual straight piping runs 100 feet and less, provide adjustable, steel clevis hangers (MSS SP-58 Type 1).
 - 2) For individual straight piping runs longer than 100 feet, provide adjustable roller hangers (MSS SP-58 Type 43).
 - c. Horizontal Multiple Piping Runs:
 - 1) For multiple straight piping runs 100 feet and longer, provide complete pipe rolls (MSS SP-58 Type 44).
 - 2) Support pipe rolls on trapezes.
 - d. For double-rod hangers having 3/8-inch minimum rods, the rod diameter may be reduced 1 size.
2. Install seismic restraints on piping in accordance with the requirements specified in Section 15071, Vibration and Seismic Controls for Mechanical Systems.
3. Maximum Hanger Spans:
 - a. Install supports for vertical cast-iron soil piping every 15 feet.
 - b. Install hangers for cast-iron soil piping with the maximum horizontal spacing and minimum rod diameters specified in Table 15160-1.

Table 15160-1 Maximum Horizontal Hanger Spacing and Minimum Rod Diameters		
Nominal Pipe Size(s)	Maximum Horizontal Hanger Spacing¹	Minimum Rod Diameter
NPS 1-1/2 and NPS 2	60 inches	3/8 inch
NPS 3	60 inches	1/2 inch
NPS 4 and NPS 5	60 inches	5/8 inch
NPS 6	60 inches	3/4 inch
NPS 8 to NPS 12	60 inches	7/8 inch



Table 15160-1 Maximum Horizontal Hanger Spacing and Minimum Rod Diameters		
Nominal Pipe Size(s)	Maximum Horizontal Hanger Spacing ¹	Minimum Rod Diameter
1. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.		

B. Piping:

1. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends.
 - a. Do not change the direction of flow more than 90 degrees.
 - b. Use the proper sizes of standard increasers and reducers if pipes of different sizes are connected.
 - c. Reducing the size of drainage piping in the direction of flow is prohibited.
2. Unless otherwise indicated in the Contract Documents, flanges and unions may be used on aboveground pressure piping.
3. Cast-Iron Soil Piping:
 - a. Provide cast-iron soil piping everywhere in the building, except within concrete columns, in accordance with the requirements specified in Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings", in the CISPI Cast Iron Soil Pipe and Fittings Handbook.
 - 1) Basic piping installation requirements are specified in Section 15050, Basic Mechanical Materials and Methods.
 - a) Coupled Pipe Joints:
 - (1) Join hubless cast-iron soil piping coupled joints according to the requirements specified in CISPI 310 and the CISPI Cast Iron Soil Pipe and Fittings Handbook.
 - b) Grooved Joints:
 - (1) Cut groove ends of pipe, and assemble the grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings in accordance with the requirements specified in AWWA C606.
4. Polyvinyl-Chloride Piping:
 - a. For rainwater leaders embedded within concrete columns, provide polyvinyl-chloride piping wrapped in 1-inch thick rigid insulation Section 15080, Mechanical Insulation.
5. Storm Drainage Piping Slopes:
 - a. Unless otherwise indicated in the Contract Documents, provide storm drainage piping at the following minimum slopes:



- 1) Building Storm Drain:
 - a) For piping NPS 3 and smaller, slope storm drainage piping 1 percent downward in the direction of flow.
 - b) For piping NPS 4 and larger; slope storm drainage piping 1 percent downward in the direction of flow.
 - 2) Horizontal Storm Drainage Piping:
 - a) Slope storm drainage piping 2 percent downward in the direction of flow.
 6. Buried Building Storm Drainage Piping:
 - a. Install buried building storm drainage piping true to the grades and alignment indicated on the Contract Drawings, with unbroken continuity of the invert.
 - b. Lay buried building storm drainage piping beginning at the low point of each system.
 - c. Place the hub ends of the piping upstream.
 - d. Install required gaskets according to manufacturer's written instructions for the use of lubricants, cements, and other installation requirements.
 - e. Maintain a swab in the piping, and pull the swab past each joint as it is completed.
 7. Wall Penetrations:
 - a. Install a wall-penetration fitting system at each service pipe penetration through the foundation wall.
 - 1) Make the wall-penetration fitting system installation watertight.
 - b. Sleeves are not required for cast iron soil piping passing through a concrete slab-on-grade if the slab does not have membrane waterproofing.
 8. Cleanouts:
 - a. Install cleanouts at grade, and extend each cleanout to where the building storm drains connect to the building storm sewers.
 - b. Install a cleanout fitting with a closure plug inside the building in the storm drainage force-main piping.
- C. Interface with Other Work:
1. If indicated on the Contract Drawings, connect interior storm drainage piping to the exterior storm drainage piping provided under Section 02630, Storm Drainage.
 - a. Provide transition fittings to join dissimilar piping materials.
 2. Connect storm drainage piping to roof drains and storm drainage piping specialties provided under Section 15165, Storm Drainage Piping Specialties.



D. Systems Integration:

1. Storm Drainage System:

- a. After the storm drainage piping provided under this Section is connected to the storm sewer and drainage piping outside the facility, building, or structure, and to the facility storm drainage piping specialties, test and inspect the completed system as specified herein.

3.03 REPAIR/RESTORATION

- A. Repair leaks and defects with new materials, and retest the repaired piping or a portion thereof until satisfactory results are obtained.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:

- a. Test storm drainage piping according to the procedures of the Authorities Having Jurisdiction, or in the absence of published procedures, as follows:
 - 1) Test new piping and parts of existing piping that have been altered, extended, or repaired for leaks and defects.
 - a) If the testing is performed in segments, submit separate reports for each test, complete with a diagram of the portion of the piping tested.
 - 2) Leave new, altered, extended, or replaced storm drainage piping uncovered and unconcealed until it has been tested and approved.
 - a) Expose work that was covered or concealed before it was tested.

b. Leak Test:



1) Test Procedure:

- a) Upon completion of storm drainage piping roughing-in, test the storm drainage piping.
- b) Close openings in the piping system, and fill the system with water to the point of overflow, but not less than to produce a 10-foot head of water.
- c) Inspect the joints for leaks.
- d) Prepare leak test reports, and document corrective action if required.
 - (1) Submit the leak test reports to the Program/Project Manager for information.

2) Acceptance Criteria:



- a) From 15 minutes before the inspection starts to completion of the inspection, the water level must not drop.
 - b) The joints may not show signs of leakage.
- 2. Inspections:
 - a. Perform the inspections specified herein in the presence of the Authorities Having Jurisdiction.
 - 1) Do not enclose, cover, or put piping into operation until it is inspected and approved by the Authorities Having Jurisdiction.
 - b. Roughing-in Inspection:
 - 1) Arrange for an inspection of the piping before concealing or closing-in after piping roughing-in.
 - c. Final Inspection:
 - 1) Arrange for a final inspection by the Authorities Having Jurisdiction to observe the tests specified herein and to ensure compliance with the specified requirements.
 - d. Inspection Reports:
 - 1) Prepare inspection reports documenting the inspections, and have them signed by the Authorities Having Jurisdiction.
 - a) Submit the inspection reports to the Program/Project Manager for information.

B. Non-Conforming Work

- 1. If the Authorities Having Jurisdiction find the piping does not pass the tests or inspections, make required corrections and arrange for a re-inspection.

3.05 SYSTEM STARTUP

A. Commissioning:

- 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, and equipment vibration control work pertinent to the Work of this Section.

3.06 CLEANING

- A. Clean the interior of storm drainage piping by removing dirt and debris as the Work progresses.**
- B. Waste Management:**
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.07 CLOSEOUT ACTIVITIES

A. As-Built Documents:

1. Prepare as-built drawings of the storm drainage system, and submit them to the Program/Project Manager for information.

3.08 PROTECTION

- A. Protect installed drains during the remainder of the construction period to prevent the drains from becoming clogged with dirt and debris, and to prevent damage from traffic and construction work.
- B. At the end of each workday and whenever the storm drainage piping Work stops, place plugs in the ends of uncompleted piping to prevent dirt and debris from entering the piping.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1.02.A.1, 1.02.C.10, 1.04.C.1, 1.05.B.1, 2.01.B.2	Add requirements for ENVISION Sustainability Rating System
2	04/05/2017	N/A	2.02.C.2	All storm drain piping, if used for downspouts in columns, wrap with 1" fiberglass.



SECTION 15165

STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for storm drainage piping specialties for facilities, buildings, or structures, and including the following:
 - a. Cleanouts.
 - b. Roof drains.
 - c. Downspout boots.
 - d. Conductor nozzles.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01732 - Cutting and Patching.
 - 3. Section 01810 – Commissioning.
 - 4. Section 02316 - Trenching and Backfilling.
 - 5. Section 15050 - Basic Mechanical Materials and Methods.
 - 6. Section 15160 - Storm Drainage Piping.
 - 7. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. NPS - Nominal Pipe Size.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. ASCE / SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 2. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASTM A112.6.3 - Floor and Trench Drains.
 - b. ASME A112.36.2M – Cleanouts.
 - 3. ASTM International (ASTM):



- a. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- b. ASTM B 32 - Standard Specification for Solder Metal.
- c. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cleanouts
 - 2) Roof Drains
 - 3) Downspout boots.
 - 4) Conductor nozzles.
 - 5) Pipe flashing.
 - 6) Sleeve flashing.
 - 7) Embedded specialty flashing.
 - b. Shop Drawings:
 - 1) Coordination Drawings.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:



1. Phoenix Building Construction Code:
 - a. Obtain approval of the Work of this Section from the Authorities Having Jurisdiction (AHJ) in accordance with requirements of the Phoenix Building Construction Code and Amendments.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Transport storm drainage piping specialties in a manner recommended by the respective manufacturers.
- B. Storage and Handling Requirements:
 1. Store and handle storm drainage piping specialties in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with requirements, provide products by one of the manufacturers listed.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:



1. Seismic Performance:
 - a. Provide storm drainage piping and supports capable of withstanding the effects of seismic events determined according to the requirements specified in ASCE / SEI 7.

D. Design Criteria:

1. Piping Systems:
 - a. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - 1) Plans, schematics, and diagrams included in the Contract Drawings indicate the sizes, profiles, and/or dimensional requirements of the plumbing specialties based on the specific system indicated.
 - 2) The indicated locations and arrangements may need to be modified based on the specific system provided and other design considerations.
 - 3) Install storm drainage-piping specialties as indicated unless deviations to the installation are approved by the Program/Project Manager on Coordination Drawings.
 - b. Working Pressure:
 - 1) Unless otherwise indicated, provide components and installations capable of producing a storm drainage-piping system with a 10-foot head of water minimum working pressure rating:
2. Product Data:
 - a. Submit Product Data for each product provided under this Section to the Program Manager for approval.

E. Materials:

1. Cleanouts:
 - a. Exposed Cast-Iron Cleanouts:
 - 1) Provide exposed cast-iron cleanouts complying with the requirements specified in ASME A112.36.2M for cleanout test tees, and having a hubless cast-iron soil pipe test tee as required to match connected piping.
 - a) Size: Furnish the same size exposed cast-iron cleanouts as the connected drainage piping.
 - b) Closure: Countersunk, cast-iron plug.
 - c) Closure Plug Size: Same as or not more than one size smaller than the cleanout size.
 - 2) Manufacturers:
 - a) Josam Company; Josam Div., www.josam.com.
 - b) MIFAB, Inc., www.mifab.com.



- c) Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc., www.jrsmith.com.
 - d) Tyler Pipe; Wade Div., www.tylerpipe.com.
 - e) Watts Water Technologies, Inc., www.watts.com.
 - f) Zurn Industries, LLC, www.Zurn.com.
 - g) Approved equal.
 - b. Cast-Iron Floor Cleanouts:
 - 1) Provide cast-iron soil pipe with cast-iron ferrule type floor cleanouts complying with the requirements specified in ASME A112.36.2M for adjustable housing cleanouts, and having a cast iron body or ferrule, adjustable cast iron housing, and a clamping device.
 - a) Size: Furnish the same size floor cleanouts as the connected branch.
 - b) Outlet Connection: Threaded.
 - c) Closure: Cast-iron plug.
 - d) Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 - e) Frame and Cover Shape: Round
 - 2) Manufacturers:
 - a) Josam Company; Josam Div., www.josam.com.
 - b) Oatey, <https://www.oatey.com/>.
 - c) Sioux Chief Manufacturing Company, Inc., www.siouxchief.com.
 - d) Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc., www.jrsmith.com.
 - e) Tyler Pipe; Wade Div., www.tylerpipe.com.
 - f) Watts Water Technologies, Inc., www.watts.com.
 - g) Zurn Industries, LLC, www.Zurn.com.
 - h) Approved equal.
- 2. Roof Drains:
 - a. Cast-Iron Roof Drains:
 - 1) Provide roof drains complying with the requirements specified in ANSI/ASTM A112.6.3, and having a cast-iron body, a polyethylene dome, a combination flashing ring and gravel stop, extension collars, and an underdeck clamp.
 - a) Pattern: Roof drain.
 - b) Outlet: Bottom.
 - 2) Manufacturers:
 - a) Josam Company; Josam Div., www.josam.com.
 - b) MIFAB, Inc., www.mifab.com.



- c) Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc., www.jrsmith.com.
 - d) Tyler Pipe; Wade Div., www.tylerpipe.com.
 - e) Watts Water Technologies, Inc., www.watts.com.
 - f) Zurn Industries, LLC, www.Zurn.com.
 - g) Approved equal.
- 3. Downspout Boots:
 - a. Provide cast-iron soil pipe downspout boots complying with the requirements specified in ASTM A 74, for Service class, hub-and-spigot, cast-iron soil pipe.
 - b. Size:
 - 1) Furnish downspout boots the same size or larger than the connected downspout.
- 4. Conductor Nozzles:
 - a. Provide bronze body conductor nozzles with threaded inlets and bronze wall flanges with mounting holes.
 - b. Size:
 - 1) Furnish the same size conductor nozzles as the connected conductor.

2.02 ACCESSORIES

- A. Sheet Flashing:
 - 1. Fabricate flashing from lead sheets.
 - a. Provide Type L51121, copper bearing lead sheet complying with the requirements specified in ASTM B 749.
 - b. Unless large pans, sumps, or other drainage shapes are required, fabricate flashing from a single piece of lead sheet.
 - c. If joining lead sheets is required, join the sheets in accordance with the following:
 - 1) For lead sheets that are 0.0938 inch thick or thicker and that weigh at least 6.0 pounds per square foot, provide burn joints.
 - 2) For lead sheets 0.0625 inch thick or thicker and weighing at least 4.0 pounds per square foot, provide solder joints.
 - d. Fasteners:
 - 1) Provide fasteners made from metal compatible with the material and substrate being fastened.
 - e. Metal Accessories:
 - 1) Provide sheet metal strips, clamps, anchoring devices, and similar accessory units required for installing the storm drainage piping specialties.



- 2) Provide metal accessories matching or compatible with the material of the specialties being installed.
- f. Solder:
 - 1) Provide lead-free alloy solder complying with the requirements specified in ASTM B 32.
2. Pipe Flashing:
 - a. Provide sleeve type pipe flashing matching the pipe size, having a minimum length of 10 inches, and having a skirt or flange extending at least 8 inches around the pipe.
3. Sleeve Flashing:
 - a. Provide flat sheet sleeve flashing having a skirt or flange extending at least 8 inches around the sleeve.
4. Embedded Specialty Flashing:
 - a. Provide flat sheet embedded specialty flashing having a skirt or flange extending at least 8 inches around the specialty.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the elements and surfaces to receive storm drainage piping specialties for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the storm drainage system.
- B. Surface Preparation:
 1. Perform excavating, trenching, and backfilling operations for storm drainage piping in accordance with the requirements specified in Section 02316, Trenching and Backfilling.
- C. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.



3.03 INSTALLATION

- A. Basic Storm Drainage Piping Specialty Installation Requirements:
 - 1. For piping adjacent to equipment, install the piping to allow access for service and maintenance.
 - 2. Escutcheons:
 - a. In exposed finished locations and within cabinets and millwork, provide escutcheons complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods, at wall, floor, and ceiling penetrations.
 - b. Provide deep-pattern escutcheons if required to conceal protruding pipe fittings.
- B. Cleanouts:
 - 1. For aboveground piping and building drain piping, unless otherwise indicated in the Contract Documents provide cleanouts according to the following:
 - a. Size:
 - 1) For drainage piping up to a nominal pipe size of NPS 4, provide cleanouts the same size as the drainage piping.
 - 2) For drainage piping larger than nominal pipe size of NPS 4, provide NPS 4 cleanouts unless a larger cleanout is indicated in the Contract Documents.
 - b. Provide a cleanout at each piping change in direction greater than 45 degrees.
 - c. Cleanouts in Long Piping Runs:
 - 1) For piping having nominal pipe sizes of NPS 4 and smaller, provide cleanouts spaced a maximum of 50 feet apart along the piping run.
 - 2) For piping having nominal pipe sizes larger than NPS 4, provide cleanouts spaced a maximum of 100 feet apart along the piping run.
 - d. Provide a cleanout at the base of each vertical soil and waste stack.
 - 2. For piping below floors, provide floor cleanouts having cleanout deck plates installed flush with the top of the finished floor.
 - 3. For concealed piping, provide cleanouts having wall access covers of the types indicated in the Contract Documents, and install each frame and cover flush with the finished wall.
- C. Roof Drains:
 - 1. Provide roof drains at low points of roof areas in accordance with the roof membrane manufacturer's written installation instructions.



- a. Where waterproof membranes are penetrated by roof drains, maintain the integrity of the waterproof roofing.
 - 1) Install roof drain flashing collars or flanges so there will be no leakage between the drain and the adjoining roofing.
 - b. Position roof drains for easy access and maintenance.
- D. Risers and Stacks:
 - 1. For each riser and stack passing through floors with waterproof membrane, provide a sleeve flashing device complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.
- E. Downspout Boots:
 - 1. Provide downspout boots at grade with the top of the hub 12 inches above grade.
- F. Conductor Nozzles:
 - 1. Provide conductor nozzles at the exposed bottom of conductors where they spill onto grade.
- G. Special Techniques:
 - 1. Sheet Flashing:
 - a. For pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane, provide sheet flashing.
 - 1) Set flashing installed on floors and roofs in a solid coating of bituminous cement.
 - 2) Secure flashing into sleeves and specialty clamping rings or devices.
- H. Interface with Other Work:
 - 1. Piping System Connections:
 - a. For piping joining materials, joint construction, and basic installation requirements, comply with the requirements specified in Section 15050, Basic Mechanical Materials and Methods and other applicable Division 15 Sections.
 - 1) Additional piping installation requirements are specified in other Sections.
- I. Systems Integration:
 - 1. Storm Drainage System:
 - a. Connect the storm drainage piping specialties provided under this Section to the storm drainage piping provided under Section 15160,



Storm Drainage Piping, and test the completed system as specified therein.

3.04 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.05 PROTECTION

- A. Protect installed drains during the remainder of the construction period to avoid clogging the drains with dirt or debris, and to prevent damage to the drains from traffic or other construction work.
- B. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15182

HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for pipe and fitting materials, joining methods, special-duty valves, and specialties for the following piping:
 - a. Chilled-water piping.
 - b. Condenser-water piping.
 - c. Makeup-water piping.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 15060 - Hangers and Supports.
 - 7. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 8. Section 15075 - Mechanical Identification.
 - 9. Section 15110 - Valves.
 - 10. Section 15122 - Expansion Fittings and Loops.
 - 11. Section 15122 - Meters and Gages.
 - 12. Section 15187 - Heating and Cooling Pumps.
 - 13. Section 15900 - HVAC Instrumentation and Controls.
 - 14. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene propylene diene terpolymer M-class rubber.
 - 3. EPT: Ethylene propylene terpolymer.
 - 4. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
 - 5. PTFE: Polytetrafluoroethylene.
 - 6. PVC: Polyvinyl-chloride.
 - 7. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
 - 8. RTRP: Reinforced thermosetting resin (fiberglass) pipe.
 - 9. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.



10. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
3. Schrader Valve: A valve having a valve stem into which a valve core, consisting of a poppet valve assisted by a spring, is threaded.
4. Working Pressure: Working pressure is equal to the relief pressure plus the static height of the system and pumping head.

C. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
 - b. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - c. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
 - d. ASME B16.4 - Gray Iron Threaded Fittings: (Classes 125 and 250).
 - e. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - f. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
 - g. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - h. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
 - i. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
 - j. ASME B31.1 - Power Piping.
 - k. ASME B31.9 - Building Services Piping.
 - l. ASME B31E - Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems.
 - m. ASME B31G - Manual for Determining the Remaining Strength of Corroded Pipeline: Supplement to ASME B31 Code for Pressure Piping.
 - n. ASME B31J - Standard Test Method for Determining Stress Intensification Factors (i-Factors) for Metallic Piping Components.
 - o. ASME B31Q - Pipeline Personnel Qualification.
 - p. ASME BPVC-VIII - ASME Boiler and Pressure Vessel Code - Section VIII: Rules for Construction of Pressure Vessels Division 1.
2. American Welding Society (AWS):



- a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- b. ANSI/AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
- c. ANSI/AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe.
- d. AWS Brazing Handbook, 5th Edition.
3. ASTM International (ASTM):
 - a. ASTM A 47/A 47M – Standard Specification for Ferritic Malleable Iron Castings.
 - b. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM A 106/A 106M – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - d. ASTM A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - e. ASTM A 234/A 234M – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - f. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - g. ASTM A 536 - Standard Specification for Ductile Iron Castings.
 - h. ASTM A 733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless-Steel Pipe Nipples.
 - i. ASTM B 32 - Standard Specification for Solder Metal.
 - j. ASTM B 75 - Standard Specification for Seamless Copper Tube.
 - k. ASTM B 75M - Standard Specification for Seamless Copper Tube (Metric).
 - l. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
 - m. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric).
 - n. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV).
 - o. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 - p. ASTM B 813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
 - q. ASTM B 828 – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - r. ASTM D 2996 - Standard Specification for Filament-Wound (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
 - s. ASTM D 4024 - Standard Specification for Machine Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges.
4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
5. Copper Development Association Inc. (CDA)



- a. CDA A4015 - The Copper Tube Handbook.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 7. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.
- 8. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
- 9. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pressure-seal fittings.
 - 2) Valves and flow and pressure drop curves.
 - 3) Air control devices.
 - 4) Chemical treatment.
 - 5) Hydronic specialties.
 - 6) Reinforced thermosetting resin (fiberglass) piping and fittings.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) Hydronic piping layout.
 - c. Qualification Statements:
 - 1) Qualifications of the pressure-sealed joint installers.
 - 2) Welding procedure specifications (WPS) test records.
 - 3) Welding Certificates.



B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Copy of the analysis of the water available at the Site.
 - b. Manufacturer's Instructions:
 - 1) Grooved joint pipe and coupling manufacturer's written installation instructions.
 - 2) Fiberglass pipe manufacturer's written installation instructions.
 - c. Site Quality Control Submittals:
 - 1) Hydrostatic Test Reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Air control devices.
 - 2) Hydronic specialties.
 - 3) Special-duty valves.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Water-Treatment Chemicals:
 - a) Furnish enough water-treatment chemicals for preventive maintenance for one year from date of Substantial Completion.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Hydronic Piping Installer's Qualifications:
 - a. Pressure-Sealed Joint Installers:
 - 1) Employ installers certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
 - 2) Submit the qualifications of the pressure-sealed joint installers to the Program/Project Manager for approval.
2. Welding Qualifications:
 - a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.



- 2) For all procedures, other than those set forth in AWS D1.1/D1.1M and ASME BPVC-IX, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
 - a) Employ procedures complying with the requirements specified in the ASME B31 Series of standards.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in AWS D1.1/D1.1M and ASME BPVC-IX.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

B. Certifications:

1. ASME Labels:

- a. Provide safety valves and pressure vessels that bear the appropriate ASME label.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers.

B. Storage and Handling Requirements:

1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
2. Protect pipe from impact shocks and free fall during handling.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



1.07 SITE CONDITIONS

- A. Existing Conditions:
 - 1. Water Analysis:
 - a. To determine the water quality available at the Site, prepare or obtain an analysis of the water.
 - b. Submit a copy of the water analysis to the Program/Project Manager for information.

PART 2 PRODUCTS

2.01 HYDRONIC PIPING SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
 - a. Volatile Organic Compounds (VOC) Content of Interior Sealants:
 - 1) Provide interior solvent cements and adhesive primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) PVC Welding: Not more than 510 grams per Liter less water.
 - b) CPVC Welding: Not more than 490 grams per Liter less water.
 - c) ABS Welding: Not more than 325 grams per Liter less water.
 - d) Adhesive Primers for Plastic: Not more than 550 grams per Liter less water.
 - e) Metal to Metal: Not more than 30 grams per Liter less water.
 - f) Fiberglass: Not more than 80 grams per Liter less water.
- C. Design Criteria:



1. The Contract Drawings indicate the general location and arrangement of the hydronic piping system.
 - a. The plans, schematics, and diagrams indicate the piping locations and arrangements used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - b. Install the hydronic piping as indicated unless deviations to the installation are approved by the Program/Project Manager on the Coordination Drawings.
 - 1) The indicated locations and arrangements may need to be modified based on the specific systems provided and other design considerations.
2. Provide materials and products, and install the hydronic piping and accessories, in accordance with the requirements specified in ASME B31.9.
3. Working Pressures and Temperatures:
 - a. Select system components so they have pressure ratings equal to or greater than the system operating pressure.
 - b. Provide piping components and an installation capable of withstanding the minimum working pressures and temperatures indicated in this Section for the following hydronic piping systems:
 - 1) Chilled-Water Piping:
 - a) The minimum working pressure and temperature for chilled-water piping systems is 125 psig (863kPa) at 200 degrees Fahrenheit (93 degrees Celsius).
 - 2) Condenser-Water Piping:
 - a) The minimum working pressure and temperature for condenser-water piping systems is 125 psig (863kPa) 150 degrees Fahrenheit (66 degrees Celsius).
 - 3) Makeup-Water Piping:
 - a) The minimum working pressure and temperature for makeup - water piping systems is 80 psig (552kPa) 150 degrees Fahrenheit (66 degrees Celsius).
4. Piping Applications:
 - a. Chilled-Water and Condenser-Water Piping:
 - 1) For aboveground, chilled-water piping having nominal pipe sizes of 2 inches (DN 50) and smaller, provide one of the following systems of piping:
 - a) Drawn-temper Type L (B) copper tubing, wrought-copper fittings, and pressure-seal joints.
 - b) Schedule 40 steel pipe, Class 150 malleable-iron fittings, cast-iron flanges and flanged fittings, and threaded joints.
 - 2) For aboveground, chilled-water and condenser-water piping having nominal pipe sizes of 2-1/2 inches (DN 65) and larger, provide one of the following systems of piping:



- a) Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- b) Schedule 40 steel pipe, grooved mechanical joint coupling and fittings, and grooved mechanical joints.
- 3) Underground Chilled Water, 2-inch and Smaller Pipe and Fittings: Underground chilled water supply and return piping shall be pre-insulated, pre-fabricated type, composed of integral sealed units of HDPE (2" Size) and PVC (1-1/2" or smaller) outer jacket, polyurethane foam insulation, and copper carrier pipe manufactured by: Perma-Pipe Rovanco Copper Pipe System, Thermal Pipe Systems, Thermacore Copper-Therm, or equal.
 - a) Outer Jacket (1-1/2" and Smaller Pipe): Seamless PVC plastic outer jacket extruded from Type I, Grade I, polyvinyl chloride, per ASTM D1784. See Table 1 for minimum wall thickness.
 - b) Outer Jacket (2" Pipe): Seamless High-Density Polyethylene (HDPE) per ASTM D1248 and D3350. Type III, Category 5, Class C. No overwrap or sprayed jacketing will be allowed. See Table 1 for minimum jacket thickness.
 - c) Carrier Pipe: ASTM B88, Type "K" Copper tubing.
 - d) Insulation: Polyurethane foam completely filling annular space between carrier pipe and outer jacket. In-place density shall be 1.9 to 2.1 pcf, with a "K" factor of 0.1 BTU/ (hour) (square foot) (degrees F/in) at 73 degrees F, and a closed cell content of 90 percent. Exposed insulation at unit ends shall be sealed with a factory-applied end seal. Minimum 1-inch thick insulation (nominal).
 - e) End Seals: Factory installed water tight end seals by the fitting and pipe manufacturer. Suitable for service ad pressure of the system. Surfaces shall be smooth and free of voids. "Painted on" end seals are not allowed.
 - f) Fittings: ANSI B16.22 wrought copper fittings. Soldered joints shall be provided with silver solder or brazing alloys with melting points at or above 1,100 °F. Tin-lead solders, with melting points less than 1,100 °F, are not permitted.
 - g) Field Joints: Carrier pipe ends shall be brazed and insulated with pre-fabricated rigid insulating half shells covered by insulating jacket or injected insulation after installation of jacket. O-Ring fittings are not allowed.
 - h) Preparation and installation of all field joints shall be observed and approved by pre-insulated pipe manufacturer's authorized representative and Project Inspector.
 - i) Thrust Blocks: Suitably sized concrete thrust blocks shall be installed at changes in direction, both vertical and horizontal, changes in pipe size, dead ends, and valves.



- j) Anchors: Where indicated on Drawings, install anchor plates attached to the carrier pipe and sealed to pipe jacketing per pipe manufacturer's recommendations.
- 4) Underground Chilled Water, 2-1/2-inch and Large Pipe and Fittings: Underground chilled water supply and return piping shall be pre-insulated, prefabricated-pipe type, composed of integral sealed units of HDPE outer jacket, polyurethane foam insulation and black steel carrier pipe manufactured by: Perma Pipe, Rovanco, Thermal Pipe Systems "Heat-Tite", Thermacor "Ferro-Therm", or equal.
 - a) Outer Jacket: Seamless High-Density Polyethylene (HDPE) per ASTM D1248 and D3350. Type III, Category 5, Class C. No overwrap or sprayed jacketing will be allowed. Tape shall not be allowed to serve as a jacket. The HDPE jacket shall be pressure tested for watertight integrity. See Table 1 for minimum jacket thickness.
 - b) Carrier Pipe: ASTM A53, Grade B, Schedule 40, black steel pipe.
 - c) Insulation: Polyurethane foam completely filling annular space between carrier pipe and outer jacket to a minimum thickness of 1 inch. In-place density shall be 1.9 to 2.1 0.14 BTU/ (hour) (square foot) degrees F/in) at 73 degrees F, and a closed cell content of 90 to 95 percent. Exposed insulation at unit ends shall be sealed with factory-applied end seal.
 - d) End Seals: Furnish factory installed watertight end seals by the jacket and carrier pipe manufacturer suitable for services and pressure of the system. Surfaces shall be smooth and free of voids. "Painted on" end seals are not allowed.
 - e) Fittings: Factory fabricated and pre-insulated with polyurethane foam insulation. Insulation shall be protected with a HDPE jacket of same thickness and quality as that of straight units of pre-insulated pipe. Miters on HDPE jacket at fittings shall be as strong as pipe outer jacket.
 - f) Expansion Elbows and Loops: Prefabricated elbows, expansion loops and tees shall be furnished where expansion compensation is indicated on the Drawings. Pre-insulated fittings that must provide compensation for pipe expansion or contraction shall be installed in a suitably sized jacket and insulated with flexible polyurethane foam insulation. Straight units adjoining expansion fittings shall also be insulated with flexible polyurethane foam insulation to compensate for lateral pipe movement. Expansion loops and elbows shall be properly designed in accordance with stress limits indicated by ANSI B31.1 Code for Pressure Piping.



- g) Thrust Blocks: Suitably sized concrete thrust blocks shall be installed at changes in direction, both vertical and horizontal, changes in pipe size, dead ends, and valves.
- h) Anchors: Prefabricated plate anchors shall be furnished where indicated on Drawings and shall consist of a steel plate welded to carrier pipe and sealed to outer jacket.
- i) Field Joints: Field joints between prefabricated units shall be installed in the following manner:
 - (1) Split or full round HDPE sleeve shall be slid over end of unit before connection of carrier pipe. Connect carrier pipe and hydrostatically test as specified.
 - (2) Center HDPE sleeves over joint area and hold in position with fiberglass tape, mix polyurethane foam components and pour into cavity according to instructions provided by manufacturer.
 - (3) Trim cured polyurethane foam flush with jacket sleeve. Center heat-actuated shrink blanket over jacket sleeve and jacket of adjoining units to provide double layer protection. Using a soft orange flame from a propane torch, work flame from center toward one end, moving rapidly back and forth and around shrink blanket. Air pockets shall be removed and worked out from under shrink blanket. At field joints with expansion provisions, wrap pipe with flexible polyurethane foam insulation and hold in place with tape and complete joint in same manner per prior instructions.
 - (4) Preparation and installation of field joints shall be observed and approved by the pre-insulated pipe manufacturer's authorized representative and the Project Inspector.
- j) Valves: Refer to Section 15053: Basic HVAC Materials and Methods. Provide valve stem extension and valve boxes.

MINIMUM THICKNESS OF HDPE JACKETS

TABLE 1	
PIPE SIZE (INCHES)	JACKET THICKNESS (INCHES)
2	0.070
2-1/2	0.070
3	0.080
4	0.080
5	0.100



6	0.100
8	0.120
10	0.120
12	0.170
14	0.200

- b. Makeup-Water Piping:
 - 1) For aboveground makeup-water piping, provide drawn-temper Type L (B) copper tubing, wrought-copper fittings, and soldered joints.
- c. Condensate-Drain Piping:
 - 1) For condensate-drain piping, provide drawn-temper Type M (C) copper tubing, wrought-copper fittings, and soldered joints.
- d. Air-Vent Piping:
 - 1) Inlet:
 - a) For inlet air-vent piping, provide the same piping as the service where the air-vent piping is installed, and having metal-to-plastic transition fittings for plastic piping systems in accordance with the piping manufacturer's written instructions.
 - 2) Outlet:
 - a) For outlet air-vent piping, provide annealed-temper Type K (A) copper tubing with soldered or flared joints.
- 5. Valve Applications:
 - a. Shutoff-Duty Valves:
 - 1) Install shutoff-duty valves at each branch connection to supply mains, and at the supply connection to each piece of equipment.
 - b. Balancing Valves:
 - 1) Install calibrated-orifice, balancing valves in the return pipe of each cooling terminal.
 - c. Check Valves:
 - 1) Install check valves at each pump discharge and elsewhere as required to control the flow direction.
 - d. Pressure-Reducing Valves:
 - 1) Install pressure-reducing valves at the makeup-water connections to regulate system fill pressure.
- 6. Product Data:
 - a. Obtain the manufacturer's Product Data for each of the following types of products and equipment:
 - 1) Pressure-seal fittings.
 - 2) Valves, including flow and pressure drop curves for calibrated-orifice balancing valves and automatic flow-control valves based on the manufacturer's testing.
 - 3) Air control devices.



- 4) Chemical treatment.
 - 5) Hydronic specialties.
 - 6) Reinforced thermosetting resin (fiberglass) piping and fittings.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- 7. Shop Drawings:
 - a. Prepare Shop Drawings of the hydronic piping layout at a scale of 1/8 inch equals 1 foot, and detail the fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of these items to the building structure.
 - 1) Detail the location of anchors, alignment guides, and expansion joints and loops
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- D. Materials:
 - 1. Copper Tube and Fittings:
 - a. Drawn-Temper Copper Tubing:
 - 1) Provide copper tubing complying with the requirements for Type L (Type B) drawn-temper copper tubing specified in ASTM B 88 (ASTM B 88M).
 - b. Annealed-Temper Copper Tubing:
 - 1) Provide copper tubing complying with the requirements for Type K (Type A) annealed -temper copper tubing specified in ASTM B 88 (ASTM B 88M).
 - c. DWV Copper Tubing:
 - 1) Provide copper tubing complying with the requirements for Type DWV copper tubing specified in ASTM B 306.
 - d. Wrought-Copper Fittings:
 - 1) Provide wrought-copper fittings complying with the requirements specified in ASME B16.22.
 - 2) Grooved-End Copper Fittings:
 - a) Provide grooved-end copper fittings complying with the requirements for copper tubes specified in ASTM B 75 (ASTM B 75M) or complying with the requirements for bronze castings specified in ASTM B 584.
 - 3) Grooved-End-Tube Couplings:
 - a) Unless otherwise indicated in the Contract Documents, provide rigid pattern grooved-end-tube copper couplings having ductile-iron housings with keys matching the pipe and fitting grooves, pre-lubricated ethylene propylene diene terpolymer M-class rubber (EPDM) gaskets rated for at least 230 degrees Fahrenheit (110 degrees Celsius) for use with the housings, and steel bolts and nuts.
 - 4) Smooth joint or "roughneck" type fittings are unacceptable.
 - 5) Manufacturers:



- a) Anvil International, Inc., a subsidiary of Mueller Water Products, Inc., <http://www.anvilintl.com>.
 - b) S. P. Fittings; a division of Star Pipe Products, <http://www.starpipeproducts.com>.
 - c) Victaulic Company of America, <http://www.victaulic.com>.
 - d) Approved equal.
2. Copper or Bronze Pressure-Seal Fittings:
 - a. Provide copper or bronze pressure-seal fittings rated for a working pressure of at least 200 psig (1379kPa) at 250 degrees Fahrenheit (121 degrees Celsius) and having a copper housing and ethylene propylene diene terpolymer M-class rubber (EPDM) O-rings and pipe stops.
 - b. Tools:
 - 1) Furnish the pressure-seal fitting manufacturer's special tools required for installing the pressure-seal fittings.
 - c. Manufacturers:
 - 1) Stadler-Viega, <http://www.viega.net>.
 - 2) Approved equal.
3. Steel Pipe and Fittings:
 - a. Steel Pipe:
 - 1) Provide black steel pipe and fittings complying with the requirements specified in ASTM A 53/A 53M, and having plain ends.
 - 2) Provide steel pipe and fittings of the types, grades, and wall thicknesses indicated in Subparagraph 2.01.C.4.
 - b. Cast-Iron Threaded Fittings:
 - 1) Provide cast-iron threaded fittings complying with the requirements specified in ASME B16.4.
 - 2) Provide Class 125 and Class 250 cast-iron fittings as indicated in Subparagraph 2.01.C.4.
 - c. Malleable-Iron Threaded Fittings:
 - 1) Provide malleable-iron threaded fittings complying with the requirements specified in ASME B16.3.
 - 2) Provide Class 150 and Class 300 malleable-iron fittings as indicated in Subparagraph 2.01.C.4.
 - d. Malleable-Iron Unions:
 - 1) Provide malleable-iron unions complying with the requirements specified in ASME B16.39.
 - 2) Provide Class 150, Class 250, and Class 300 malleable-iron unions as indicated in Subparagraph 2.01.C.4.
 - e. Cast-Iron Pipe Flanges and Flanged Fittings:
 - 1) Provide raised ground face cast-iron pipe flanges and flanged fittings complying with the requirements specified in ASME B16.1, and having spot faced bolt holes.



- 2) Provide Class 25, Class 125, and Class 250 cast-iron pipe flanges and flanged fittings as indicated in Subparagraph 2.01.C.4.
- f. Wrought-Steel Fittings:
 - 1) Provide wrought-steel fittings complying with the requirements specified in ASTM A 234/A 234M, and having a wall thickness matching the wall thickness of the adjoining pipe.
- g. Wrought Cast-Steel and Forged-Steel Flanges and Flanged Fittings:
 - 1) Provide wrought cast-steel and forged-steel flanges and flanged fittings complying with the requirements specified in ASME B16.5, and including the bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a) Material Group: 1.1.
 - b) End Connections: Butt welding.
 - c) Facings: Raised face.
- h. Grooved Mechanical-Joint Fittings and Couplings:
 - 1) Joint Fittings:
 - a) Provide grooved mechanical-joint fittings of the following types:
 - (1) Provide ductile iron joint fittings complying with the requirements for Grade 65-45-12 ductile iron specified in ASTM A 536, Grade 65-45-12 ductile iron
 - (2) Provide malleable iron joint fittings complying with the requirements for Grade 32510 malleable iron specified in ASTM A 47/A 47M.
 - (3) Provide fabricated steel joint fittings complying with the requirements for Type F, E, or S, Grade B steel specified in ASTM A 53/A 53M.
 - (4) Provide steel joint fittings complying with the requirements for Grade B steel specified in ASTM A 106/A 106M, having grooves or shoulders constructed to accept grooved-end couplings, and having nuts, bolts, locking pins, locking toggles, or lugs to secure the grooved pipe and fittings.
 - 2) Couplings:
 - a) Provide grooved mechanical-joint couplings having a ductile-iron or malleable-iron housing; a synthetic rubber gasket of the central cavity pressure-responsive design; and nuts, bolts, locking pins, locking toggles, or lugs to secure the grooved pipe and fittings.
 - 3) Smooth joint or "roughneck" type fittings are unacceptable.
 - 4) Manufacturers:
 - a) Anvil International, Inc., a subsidiary of Mueller Water Products, Inc., <http://www.anvilintl.com>.
 - b) Central Sprinkler Company; a division of Tyco Fire & Building Products, <http://www.tyco-fire.com>.



- c) National Fittings, Inc.
 - d) S. P. Fittings; a division of Star Pipe Products, <http://www.starpipeproducts.com>.
 - e) Victaulic Company of America, <http://www.victaulic.com>.
 - f) Approved equal.
 - i. Steel Pressure-Seal Fittings:
 - 1) Provide steel pressure-seal fittings having a rated working-pressure of at least 300 psig (2070kPa) at 230 degrees Fahrenheit (110 degrees Celsius).
 - a) Housing:
 - (1) Provide steel pressure-seal fittings having steel housings.
 - b) O-Rings and Pipe Stop:
 - (1) Provide steel pressure-seal fittings having ethylene propylene diene terpolymer M-class rubber (EPDM) O-rings and pipe stop.
 - 2) Tools:
 - a) Furnish the manufacturer's special tool required for installing the steel pressure-seal fittings.
 - j. Manufacturers:
 - a) Victaulic Company of America, <http://www.victaulic.com>.
 - b) Approved equal.
 - k. Steel Pipe Nipples:
 - 1) Provide steel pipe nipples complying with the requirements specified in ASTM A 733, and made of same materials and having the same wall thicknesses as the pipe in which they are installed.
- 4. Fiberglass Pipe and Fittings:
 - a. Fiberglass Pipe:
 - 1) Provide reinforced thermosetting resin (fiberglass) pipe (RTRP) complying with the requirements specified in ASTM D 2996.
 - b. Fiberglass Fittings:
 - 1) Provide either compression or spray-up/contact molded reinforced thermosetting resin (fiberglass) fittings (RTRF) fabricated from the same material and having the same pressure class and joining method as the pipe.
 - c. Fiberglass Flanges:
 - 1) Provide reinforced thermosetting resin (fiberglass) flanges complying with the requirements specified in ASTM D 4024.
 - 2) Gaskets:
 - a) Provide full-face gaskets suitable for the service, having a minimum thickness of 1/8 inch (3.2mm), and a durometer hardness of in the 60 to 70 range.
 - 3) Hardware:
 - a) Provide hex head bolts complying with the requirements for Grade B bolts specified in ASTM A 307 and washers.
- 5. Joining Materials:



- a. Pipe-Flange Gasket Materials:
 - 1) Provide nonmetallic, flat, asbestos free pipe-flange gaskets complying with the requirements specified in ASME B16.21, and suitable for the chemical and thermal conditions of the piping system contents.
 - a) Thickness:
 - (1) Unless the gasket thickness or specific material is indicated in the Contract Documents, provide pipe-flange gaskets no more than 1/8 inch (3.2mm) thick.
 - b) Full-Face Type:
 - (1) For flat-face, Class 125, cast-iron and cast-bronze flanges, provide full-face type pipe-flange gaskets.
 - c) Narrow-Face Type:
 - (1) For raised-face, Class 250, cast-iron and steel flanges, provide narrow -face type pipe-flange gaskets.
- b. Flange Bolts and Nuts:
 - 1) Unless otherwise indicated in the Contract Documents, provide carbon steel flange bolts and nuts complying with the requirements specified in ASME B18.2.1.
- c. Solder Filler Metals:
 - 1) Provide solder filler metals complying with the requirements for lead-free alloys specified in ASTM B 32.
 - 2) Provide water-flushable flux complying with the requirements specified in ASTM B 813.
- d. Brazing Filler Metals:
 - 1) Provide brazing filler metals complying with the requirements specified in ANSI/AWS A5.8/A5.8M.
 - a) For joining copper with copper, provide BCuP Series copper-phosphorus alloy brazing filler metals.
 - b) For joining copper with bronze or steel, provide BAg-1 silver alloy brazing filler metals.
- e. Welding Filler Metals:
 - 1) Provide welding filler metals complying with the requirements specified in ANSI/AWS D10.12M/D10.12, and appropriate for the wall thickness and chemical analysis of the steel pipe being welded.
- f. Fiberglass Pipe Adhesive:
 - 1) Provide adhesive for joining fiberglass pipe furnished or recommended by the fiberglass pipe manufacturer.
- g. Gasket Material:
 - 1) Provide the thickness, material, and type of gasket material suitable for the fluid to be handled and for the working temperatures and pressures.



6. Dielectric Fittings:
 - a. Provide combination dielectric fittings fabricated from copper-alloy and ferrous materials; and having threaded, solder-joint, plain, or weld-neck end connections that match the piping system materials.
 - b. Insulating Material:
 - 1) Provide insulating material suitable for the system fluid, pressure, and temperature.
 - c. Dielectric Unions:
 - 1) Provide factory-fabricated dielectric union assemblies rated for a working pressure of at least 250 psig (1725kPa) at 180 degrees Fahrenheit (82 degrees Celsius).
 - 2) Manufacturers:
 - a) Capitol Manufacturing Company, <http://www.capitolcamco.com>.
 - b) Central Plastics Company, <http://www.centralplastics.com>.
 - c) Hart Industries International, Inc., <http://www.hartindustries.com>.
 - d) Watts Regulator Co.; a division of Watts Water Technologies, Inc., <http://www.watts.com>.
 - e) Zurn Plumbing Products Group; AquaSpec Commercial Products Division, <http://www.zurn.com>.
 - f) Approved equal.
 - d. Dielectric Flanges:
 - 1) Provide factory-fabricated companion-flange assemblies rated for working pressures of at least 150 psig (1035kPa) or 300 psig (2070kPa) as required to suit the system pressures.
 - 2) Manufacturers:
 - a) Capitol Manufacturing Company, <http://www.capitolcamco.com>.
 - b) Central Plastics Company, <http://www.centralplastics.com>.
 - c) Watts Regulator Co.; a division of Watts Water Technologies, Inc., <http://www.watts.com>.
 - d) Approved equal.
 - e. Dielectric-Flange Kits:
 - 1) Provide companion-flange assemblies designed for field assembly, and that include flanges, full-face- or ring-type neoprene or phenolic gaskets, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 2) The separate companion flanges and steel bolts and nuts must be rated for working pressures of at least 150 psig (1035kPa) or 300 psig (2070kPa) where required to suit system pressures.
 - 3) Manufacturers:
 - a) Advance Products and Systems, Inc., <http://www.apsonline.com/index.html>.



- b) Calpico, Inc.,
http://www.calpicoinc.com/uploads/wall_sleeves.pdf.
 - c) Central Plastics Company, <http://www.centralplastics.com>.
 - d) Pipeline Seal and Insulator, Inc., <http://www.pipelineal.com>.
 - e) Approved equal.
 - f. Dielectric Couplings:
 - 1) Provide galvanized-steel dielectric couplings having inert and noncorrosive thermoplastic linings, threaded ends, and that are rated for a working pressure of at least 300 psig (2070kPa) at 225 degrees Fahrenheit (107 degrees Celsius).
 - 2) Manufacturers:
 - a) Calpico, Inc.,
http://www.calpicoinc.com/uploads/wall_sleeves.pdf.
 - b) Lochinvar Corporation, <http://www.lochinvar.com>.
 - c) Approved equal.
 - g. Dielectric Nipples:
 - 1) Provide electroplated steel nipples having inert and noncorrosive, thermoplastic linings; plain, threaded, or grooved ends; and that are rated for a working pressure of at least 300 psig (2070kPa) at 225 degrees Fahrenheit (107 degrees Celsius).
 - 2) Manufacturers:
 - a) Perfection Corporation (Elster Perfection); a subsidiary of American Meter Company, <https://www.elster-perfection.com/>.
 - b) Precision Plumbing Products, Inc., <http://www.pppinc.net>.
 - c) Sioux Chief Manufacturing Company, Inc.,
<http://www.siouxchief.com>.
 - d) Victaulic Company of America, <http://www.victaulic.com>.
 - e) Approved equal.
- 7. Valves:
 - a. Check, Ball, and Butterfly Valves:
 - 1) Provide check, ball, and butterfly valves complying with requirements specified in Section 15110, Valves.
 - b. Automatic Temperature-Control Valves, Actuators, and Sensors:
 - 1) Provide automatic temperature-control valves, actuators, and sensors complying with requirements specified in Section 15900, HVAC Instrumentation and Controls.
 - c. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1) Provide bronze, calibrated-orifice, balancing valves having the following additional features:
 - a) Bodies:
 - (1) Provide bronze balancing ball or plug type valves having a calibrated orifice or venturi.
 - b) Balls:
 - (1) Provide balancing valves having brass or stainless-steel balls.



- c) Plugs:
 - (1) Provide balancing valves having resin plugs.
- d) Seats:
 - (1) Provide balancing valves having polytetrafluoroethylene (PTFE) seats.
- e) End Connections:
 - (1) Provide balancing valves having threaded or socket end connections.
- f) Pressure Gage Connections:
 - (1) Provide balancing valves having integral seals for portable differential pressure meter connections.
- g) Handle Style:
 - (1) Provide balancing valves having lever type handles with a memory stop to retain a set position.
- h) Cold Working Pressure (CWP) Rating:
 - (1) Provide balancing valves having a cold working pressure of at least 125 psig (860kPa).
- i) Operating Temperature:
 - (1) Provide balancing valves having an operating temperature not greater than 250 degrees Fahrenheit (121 degrees Celsius).
- 2) Manufacturers:
 - a) Armstrong Pumps, Inc., <http://www.pumpproducts.com/armstrong-m-10.html>.
 - b) Bell & Gossett Domestic Pump; a division of ITT Industries, <http://www.bellgossett.com>.
 - c) Flow Design, Inc., <http://www.flowdesign.com>.
 - d) Gerand Engineering Co., <http://www.gerandengineeringco.com>.
 - e) Griswold Controls, <http://www.griswoldcontrols.com>.
 - f) Taco, Inc., <http://www.taco-hvac.com>.
 - g) Approved equal.
- d. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
 - 1) Provide cast-iron or steel, calibrated-orifice, balancing valves having the following additional features:
 - a) Bodies:
 - (1) Provide cast-iron or steel body, ball, plug, or globe pattern balancing valves having a calibrated orifice or venturi.
 - b) Balls:
 - (1) Provide balancing valves having brass or stainless-steel balls.
 - c) Stem Seals:
 - (1) Provide balancing valves having ethylene propylene diene terpolymer M-class rubber (EPDM) O-ring stem seals.
 - d) Discs:



- (1) Provide balancing valves having glass and carbon-filled polytetrafluoroethylene (PTFE) discs.
- e) Seats:
 - (1) Provide balancing valves having polytetrafluoroethylene (PTFE) seats.
- f) End Connections:
 - (1) Provide balancing valves having flanged or grooved end connections.
- g) Pressure Gage Connections:
 - (1) Provide balancing valves having integral seals for portable differential pressure meter connections.
- h) Handle Style:
 - (1) Provide balancing valves having lever type handles with a memory stop to retain a set position.
- i) Cold Working Pressure (CWP) Rating:
 - (1) Provide balancing valves having a cold working pressure of at least 125 psig (860kPa).
- j) Operating Temperature:
 - (1) Provide balancing valves having an operating temperature not greater than 250 degrees Fahrenheit (121 degrees Celsius).
- 2) Manufacturers:
 - a) Armstrong Pumps, Inc., <http://www.armstrongpumps.com>.
 - b) Bell & Gossett Domestic Pump; a division of ITT Industries, <http://www.bellgossett.com>.
 - c) Flow Design, Inc., <http://www.flowdesign.com>.
 - d) Gerand Engineering Co., <http://www.gerandengineeringco.com>.
 - e) Griswold Controls, <http://www.griswoldcontrols.com>.
 - f) Approved equal.
- e. Diaphragm-Operated, Pressure-Reducing Valves:
 - 1) Provide diaphragm-operated, pressure-reducing valves having the following additional features:
 - a) Bodies:
 - (1) Provide pressure-reducing valves having bronze or brass bodies.
 - b) Discs:
 - (1) Provide pressure-reducing valves having glass and carbon-filled Polytetrafluoroethylene (PTFE) discs.
 - c) Seats:
 - (1) Provide pressure-reducing valves having brass seats.
 - d) Stem Seals:
 - (1) Provide pressure-reducing valves having ethylene propylene diene terpolymer M-class rubber (EPDM) O-ring stem seals.



- e) Diaphragms:
 - (1) Provide pressure-reducing valves having ethylene propylene terpolymer (EPT) diaphragms.
- f) Provide pressure-reducing valves having a low inlet-pressure check valve.
- g) Inlet Strainers:
 - (1) Provide pressure-reducing valves having bronze inlet strainers, removable without having to shut down the system.
- h) Valve Seats and Stems:
 - (1) Provide pressure-reducing valves having noncorrosive valve seats and stems.
- i) Valve Size, Capacity, and Operating Pressure:
 - (1) Provide pressure-reducing valves selected to suit the system in which they are to be installed, and having the operating pressure and capacity factory set but field adjustable.
- 2) Manufacturers:
 - a) Amtrol, Inc., <http://www.amtrol.com/index.htm>.
 - b) Armstrong Pumps, Inc., <http://www.armstrongpumps.com>.
 - c) Bell & Gossett Domestic Pump; a division of ITT Industries, <http://www.bellgossett.com>.
 - d) Apollo Valves, manufactured by Conbraco Industries, Inc., <http://www.apollovalves.com>.
 - e) Spence Engineering Company, Inc., <http://www.spenceengineering.com>.
 - f) Watts Regulator Co.; a division of Watts Water Technologies, Inc., <http://www.watts.com>.
 - g) Approved equal.
- f. Automatic Flow-Control Valves:
 - 1) Provide automatic flow-control valves having the following additional features:
 - a) Bodies:
 - (1) Provide automatic flow-control valves having brass or ferrous metal bodies.
 - b) Piston and Spring Assemblies:
 - (1) Provide automatic flow-control valves having stainless steel, tamper proof, self-cleaning, and removable piston and spring assemblies.
 - c) Combination Assemblies:
 - (1) Provide a bronze or brass-alloy ball valve in combination automatic flow-control valve assemblies.
 - d) Identification Tags:
 - (1) Provide automatic flow-control valves marked with the zone identification, valve number, and flow rate.



- e) Size:
 - (1) Provide automatic flow-control valves having the same size as the pipe in which they are installed.
- f) Performance:
 - (1) Provide automatic flow-control valves that maintain a constant flow, plus or minus 5 percent over the system pressure fluctuations.
- g) Cold Working Pressure (CWP) Rating:
 - (1) Provide automatic flow-control valves having a cold working pressure of at least 175 psig (1207kPa).
- h) Operating Temperature:
 - (1) Provide automatic flow-control valves having an operating temperature not greater than 200 degrees Fahrenheit (93 degrees Celsius).
- 2) Manufacturers:
 - a) Flow Design, Inc., <http://www.flowdesign.com>.
 - b) Griswold Controls, <http://www.griswoldcontrols.com>.
 - c) Approved equal.
- 8. Air Control Devices:
 - a. Manual Air Vents:
 - 1) Provide manual air vents having the following additional features:
 - a) Bodies:
 - (1) Provide manual air vents having bronze bodies.
 - b) Internal Parts:
 - (1) Provide manual air vents having nonferrous internal parts.
 - c) Operators:
 - (1) Provide manual air vents having screwdriver or thumbscrew operators.
 - d) Inlet Connections:
 - (1) Provide manual air vents having 1/2 inch (DN 15) nominal pipe size inlet connections.
 - e) Discharge Connections:
 - (1) Provide manual air vents having 1/8 inch (DN 6) nominal pipe size discharge connections.
 - f) Cold Working Pressure (CWP) Rating:
 - (1) Provide manual air vents having a cold working pressure of at least 150 psig (1035kPa).
 - g) Operating Temperature:
 - (1) Provide manual air vents having an operating temperature not greater than 225 degrees Fahrenheit (107 degrees Celsius).
 - b. Automatic Air Vents:
 - 1) Provide automatic air vents having the following additional features:
 - a) Bodies:



- (1) Provide automatic air vents having bronze or cast-iron bodies.
 - b) Internal Parts:
 - (1) Provide automatic air vents having nonferrous internal parts.
 - c) Operators:
 - (1) Provide automatic air vents having noncorrosive metal float operators.
 - d) Inlet Connections:
 - (1) Provide automatic air vents having 1/2 inch (DN 15) nominal pipe size inlet connections.
 - e) Discharge Connections:
 - (1) Provide automatic air vents having 1/4 inch (DN 8) nominal pipe size discharge connections.
 - f) Cold Working Pressure (CWP) Rating:
 - (1) Provide automatic air vents having a cold working pressure of at least 150 psig (1035kPa).
 - g) Operating Temperature:
 - (1) Provide manual air vents having an operating temperature not greater than 240 degrees Fahrenheit (116 degrees Celsius).
- c. Expansion Tanks:
- 1) Provide the following general features with all expansion tanks provided under this Section:
 - a) Tanks:
 - (1) Provide a welded steel tank rated for a working pressure of 125 psig (860kPa) and a maximum operating temperature of 375 degrees Fahrenheit (191 degrees Celsius) and having taps in the bottom of the tank for a tank fitting and taps in end of the tank for a gage glass.
 - (2) Provide factory-tested tanks having taps fabricated and labeled in accordance with the requirements specified in ASME BPVC-VIII.
 - b) Air-Control Tank Fittings:
 - (1) Provide an air-control tank fitting sized for the compression-tank diameter.
 - (2) Provide tank fittings designed for a working pressure of 125 psig (860kPa) and a maximum operating temperature of 250 degrees Fahrenheit (121 degrees Celsius).
 - (3) For 100-gallon (379L) units only, provide an air-control tank fitting having a cast-iron body, a copper-plated tube, a brass vent tube plug, and a stainless-steel ball check.
 - c) Tank Drain Fittings:



- (1) Provide tank drain fittings designed and constructed to admit air to the compression tank, drain water, and close off the system.
 - (2) Provide tank drain fittings having a brass body, nonferrous internal parts.
 - (3) Provide tank drain fittings designed for a working pressure of 125 psig (860kPa) and a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- d) Gage Glasses:
 - (1) Provide a full height 3/4-inch (20mm) diameter gage glass having dual manual shutoff valves and a slotted-metal glass guard.
- 2) Bladder-Type Expansion Tanks:
 - a) Provide bladder-type expansion tanks having the following additional features:
 - (1) Tanks:
 - (a) Provide bladder-type welded steel expansion tanks rated for a working pressure of 125 psig (860kPa) and a maximum operating temperature 375 degrees Fahrenheit (191 degrees Celsius).
 - (b) Provide factory-tested tanks having taps fabricated and supports installed and labeled in accordance with the requirements specified in ASME BPVC-VIII.
 - (2) Bladders:
 - (a) Provide bladder-type expansion tanks having their bladders securely sealed into the tank to separate the air charge from the system water to maintain the required expansion capacity.
 - (3) Air-Charge Fittings:
 - (a) Provide bladder-type expansion tanks having a stainless-steel Schrader valve with ethylene propylene diene terpolymer M-class rubber (EPDM) seats.
- 3) Tangential-Type Air Separators:
 - a) Provide tangential-type air separators having the following additional features:
 - (1) Tanks:
 - (a) Provide welded steel tangential-type air separators having constructed and labeled in accordance with ASME requirements and having a minimum working pressure of 125 psig (860kPa) and a maximum operating temperature of 375 degrees Fahrenheit (191 degrees Celsius).
 - (2) Air Collector Tubes:



- (a) Provide tangential-type air separators having perforated stainless steel air collector tubes, designed and constructed to direct released air into an expansion tank.
 - (3) Tangential Inlet and Outlet Connections:
 - (a) For tangential-type air separators having nominal pipe sizes of 2 inches (DN 50) and smaller, provide threaded tangential inlet and outlet connections.
 - (b) For tangential-type air separators having nominal pipe sizes of 2-1/2 inches (DN 65) and larger, provide; flanged tangential inlet and outlet connections.
 - (4) Blowdown Connections:
 - (a) Provide tangential-type air separators having threaded blowdown connections.
 - (5) Size:
 - (a) Provide tangential-type air separators of the size matching the system flow capacity.
- 4) Inline Air Separators:
 - a) Provide inline air separators having the following additional features:
 - (1) Tanks:
 - (a) Provide inline air separators having one-piece cast iron tanks with an integral weir designed and constructed to decelerate the system flow so air separation is maximized.
 - (2) Working Pressure:
 - (a) Provide inline air separators having a maximum working pressure of 175 psig (1207kPa).
 - (3) Operating Temperature:
 - (a) Provide inline air separators having a maximum operating temperature of 300 degrees Fahrenheit (149 degrees Celsius).
- 5) Manufacturers:
 - a) Amtrol, Inc., <http://www.amtrol.com/index.htm>.
 - b) Armstrong Pumps, Inc., <http://www.pumpproducts.com/armstrong-m-10.html>.
 - c) Bell & Gossett Domestic Pump; a division of ITT Industries, <http://www.bellgossett.com>.
 - d) Approved equal.
- 9. Chemical Treatment:
 - a. Bypass Chemical Feeders:
 - 1) Provide welded steel bypass chemical feeders having a fill funnel and inlet, outlet, and drain valves.
 - 2) Capacity:



- a) Provide bypass chemical feeders having a 5 gallon (19L) capacity.
 - 3) Working Pressure:
 - a) Provide bypass chemical feeders having a working pressure of 125 psig (860kPa).
 - 4) Chemicals:
 - a) To prevent an accumulation of scale and corrosion in piping and connected equipment, provide chemicals, specially formulated based on an analysis of the makeup water, for the bypass chemical feeders.
- 10. Hydronic Piping Specialties:
 - a. Y-Pattern Strainers:
 - 1) Provide Y-pattern strainers having the following additional features:
 - a) Bodies:
 - (1) Provide Y-pattern strainers having cast iron bodies complying with the requirements for Class B cast iron specified in ASTM A 126, and having a bolted cover and bottom drain connection.
 - b) End Connections:
 - (1) For Y-pattern strainers having nominal pipe sizes of 2 inches (DN 50) and smaller, provide threaded end connections.
 - (2) For Y-pattern strainers having nominal pipe sizes of 2-1/2 inches (DN 65) and larger, provide flanged end connections.
 - c) Strainer Screens:
 - (1) Provide Y-pattern strainers having 40-mesh startup strainer screens and perforated stainless-steel basket screens having a 50 percent free area.
 - d) Cold Working Pressure (CWP) Rating:
 - (1) Provide balancing valves having a cold working pressure of at least 125 psig (860kPa).
 - b. Flexible Connectors:
 - 1) Provide spherical flexible connectors having the following additional features:
 - a) Bodies:
 - (1) Provide flexible connectors having fiber-reinforced rubber bodies.
 - b) End Connections:
 - (1) Provide flexible connectors having steel flange end connections drilled to align with Class 150 and Class 300 steel flanges.
 - c) Performance:



- (1) Provide flexible connectors capable functioning normally when misaligned.
 - d) Cold Working Pressure (CWP) Rating:
 - (1) Provide balancing valves having a cold working pressure of 150 psig (1035kPa).
 - e) Operating Temperature:
 - (1) Provide flexible connectors having an operating temperature not greater than 250 degrees Fahrenheit (121 degrees Celsius).
- E. Shop Fabrication:
 - 1. Fabricate and stamp air separators and expansion tanks in accordance with the requirements specified in ASME BPVC-VIII.

2.02 ACCESSORIES

- A. Expansion Fittings:
 - 1. Provide expansion fittings complying with the requirements specified in Section 15122, Expansion Fittings and Loops.
- B. Pumps:
 - 1. Provide pumps, pump motors, and accessories complying with the requirements specified in Section 15187, Heating and Cooling Pumps.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the elements and surfaces to receive hydronic piping for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the hydronic piping.
- B. Surface Preparation:
 - 1. For piping penetrations of walls, ceilings, and floors, install sleeves.
- C. Demolition/Removal:



1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions under observation of manufacturer's technical representative.
- B. Manufacturer's technical representative shall determine if handling, storage and installation is being performed in accordance with manufacturer's recommendations and is to be present during critical periods of installation and testing of system. Before Substantial Completion, deliver to the ARCHITECT a certificate from manufacturer stating the installation is satisfactory and was performed in accordance with manufacturer's recommendations.
- C. Inspections and Tests:
 1. Welding Inspection: In accordance with Section 15053.
 2. Pressure Testing: In accordance with Section 15053 and following:
 - a. Test at ~~200 psi~~. Maintain test pressure for at least 4 hours, observed by the Project Inspector, to prove tightness without leaks.
 3. Field Joint Inspection:
 - a. Verify installation of insulation at all field joints. Installation of field applied insulation and jackets shall be observed by the Project Inspector.
4. Video Recording of Underground Installation:
 - a. Prior to backfill, the CONTRACTOR shall video record the entire extent of the underground piping installation. The video recording shall also note depths, and locations of fittings.
 - b. The video recording shall be developed on a 12 cm, DVD disk. Provide (3) copies of the DVD recording to the Project Inspector for approval by the ARCHITECT, prior to backfill.
 - c. Provide (1) copy of the DVD recording within the underground piping "as-built" drawing submittal package.
- F. Backfill: For excavation, fill, import and export of materials refer to Section 02316, Trenching and Backfilling.
 1. Immediately after piping is installed in trench, a partial backfill shall be provided in middle of each unit leaving joints exposed for inspection before hydrostatic tests. After all thrust blocks are installed, a hydrostatic test shall be performed.
 2. After hydrostatic testing, final backfill of selected earth shall be hand-packed and hand-tamped to 12-inch minimum over top of jacket. Remainder of backfill shall be free of large boulders, rocks over 6-inch





in diameter, frozen earth, or foreign matter. Do not furnish wheeled or tracked vehicles for tamping of backfill.

- D. Detectable Warning Tape: Provide and install detectable marking tape along buried piping per Section 15077, Identification for HVAC Piping and Equipment.
- E. Hangers and Supports:
1. Provide hanger, support, and anchor devices complying with the requirements specified in Section 15060, Hangers and Supports.
 2. Provide seismic restraints complying with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
 3. Types of Supports:
 - a. For individual horizontal pipes less than 20 feet (6m) long, provide adjustable steel clevis hangers.
 - b. For individual horizontal pipes 20 feet (6m) or longer, provide adjustable roller hangers and spring hangers.
 - c. For multiple horizontal pipes 20 feet (6 m) or longer, provide pipe rollers complying with the requirements for Type 44 rollers specified in MSS SP-58, and supported on a trapeze.
 - d. For supporting vertical runs, provide spring hangers.
 - e. For hangers and supports in direct contact with copper pipe, provide copper-clad hangers and supports.
 4. Hangers for Steel Piping:
 - a. For a 3/4 inch (DN 20) nominal steel pipe size, do not space pipe hangers more than 7 feet (2.1m) apart, and do not provide hanger rods less than 1/4 inch (6.4mm) in diameter.
 - b. For a 1 inch (DN 25) nominal steel pipe size, do not space pipe hangers more than 7 feet (2.1m) apart, and do not provide hanger rods less than 1/4 inch (6.4mm) in diameter.
 - c. For a 1-1/2 inch (DN 40) nominal steel pipe size, do not space pipe hangers more than 9 feet (2.7m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - d. For a 2 inch (DN 50) nominal steel pipe size, do not space pipe hangers more than 10 feet (3.0m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - e. For a 2-1/2 inch (DN 65) nominal steel pipe size, do not space pipe hangers more than 11 feet (3.4m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - f. For a 3 inch (DN 65) nominal steel pipe size, do not space pipe hangers more than 12 feet (3.7m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - g. For a 4 inch (DN 100) nominal steel pipe size, do not space pipe hangers more than 14 feet (4.3m) apart, and do not provide hanger rods less than 1/2 inch (13mm) in diameter.



- h. For a 6 inch (DN 150) nominal steel pipe size, do not space pipe hangers more than 17 feet (5.2m) apart, and do not provide hanger rods less than 1/2 inch (13mm) in diameter.
 - i. For an 8 inch (DN 200) nominal steel pipe size, do not space pipe hangers more than 19 feet (5.8m) apart, and do not provide hanger rods less than 5/8 inch (16mm) in diameter.
 - 5. Hangers for Drawn-Temper Copper Piping:
 - a. For a 3/4 inch (DN 20) nominal drawn-temper copper pipe size, do not space pipe hangers more than 5 feet (1.5m) apart, and do not provide hanger rods less than 1/4 inch (6.4mm) in diameter.
 - b. For a 1 inch (DN 25) nominal drawn-temper copper pipe size, do not space pipe hangers more than 6 feet (1.8m) apart, and do not provide hanger rods less than 1/4 inch (6.4mm) in diameter.
 - c. For a 1-1/2 inch (DN 40) nominal drawn-temper copper pipe size, do not space pipe hangers more than 8 feet (2.4m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - d. For a 2 inch (DN 50) nominal drawn-temper copper pipe size, do not space pipe hangers more than 8 feet (2.4m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - e. For a 2-1/2 inch (DN 65) nominal drawn-temper copper pipe size, do not space pipe hangers more than 9 feet (2.7m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - f. For a 3 inch (DN 80) nominal drawn-temper copper pipe size, do not space pipe hangers more than 10 feet (3.0m) apart, and do not provide hanger rods less than 3/8 inch (10mm) in diameter.
 - 6. Support vertical runs at the roof, at each floor, and at 10-foot (3m) intervals between floors.

F. Piping:

- 1. Except in equipment rooms and service areas, install piping in concealed locations unless otherwise indicated in the Contract Documents.
 - a. In equipment rooms and service areas, install piping exposed and either at right angles or parallel to building walls.
 - b. Unless specifically indicated otherwise in the Contract Documents, diagonal runs are prohibited.
 - c. When installing piping above accessible ceilings, allow sufficient space to remove the ceiling panels.
- 2. Install piping so installed valves can be serviced.
- 3. Install piping free of sags and bends, and so it has the slopes indicated in the Contract Documents.
 - a. Install piping at a uniform grade of 0.2 percent upward in the direction of flow.
- 4. Install groups of pipes parallel to each other, and space the pipes so insulation can be applied and installed valves can be serviced.
 - a. When installing piping to be insulated, allow sufficient space to install or apply the insulation.



5. For changes in direction and branch connections, provide fittings.
 - a. For installing branch connections to mains, provide tee fittings in the main pipe, and connect the branch connected to the bottom of the main pipe.
 - b. For up-feed risers, connect the branch to the top of the main pipe.
6. Pipe Unions:
 - a. For piping having nominal pipe sizes of 2 inches (DN 50) and smaller, for piping adjacent to valves, at the final connections of equipment, and elsewhere when indicated in the Contract Documents, provide pipe unions.
7. Pipe Flanges:
 - a. For piping having nominal pipe sizes of 2-1/2 inches (DN 65) and larger, at the final connections of equipment, and elsewhere when indicated in the Contract Documents, provide pipe flanges.
8. To reduce pipe sizes, provide eccentric reducer fittings installed with the level side up.
9. Expansion:
 - a. To protect piping from damage due to expansion, provide expansion loops, expansion joints, anchors, and pipe alignment guides for the piping in accordance with the requirements specified in Section 15122, Expansion Fittings and Loops.
10. Piping Penetrations:
 - a. For piping penetrations of exterior concrete walls and slabs, provide sleeve seals.
 - b. For piping penetrations of walls, ceilings, and floors, provide escutcheons.
11. Drains:
 - a. At low points in the piping system mains and elsewhere as required for system drainage, provide drains consisting of a tee fitting, and a ball valve, a short-threaded nipple, and a pipe cap having 3/4 inch (DN 20) nominal pipe sizes.
12. Strainers:
 - a. On the inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated in the Contract Documents, provide strainers.
 - 1) For strainers having a nominal pipe size 2 inch (DN 50), provide a nipple and ball valve having 3/4 inch (DN 20) nominal pipe sizes in the blowdown connection.
 - 2) For strainers having a nominal pipe size smaller than 2 inch (DN 50), provide a nipple and ball valve matching the size of the strainer blowoff connection.

G. Pipe Joints:

1. Ream the ends of pipes and tubes, and remove burrs.
 - a. Bevel the plain ends of steel pipe.



2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints:
 - a. Unless otherwise indicated in the Contract Documents, apply water-flushable flux complying with the requirements specified in ASTM B 813 to the tube end.
 - b. Construct the soldered joints in accordance with the requirements specified in ASTM B 828 or CDA A4015, using lead-free solder alloy complying with the requirements specified in ASTM B 32.
4. Brazed Joints:
 - a. Construct the brazed joints in accordance with the requirements specified in Chapter 35, Pipe and Tubing, of the 5th Edition of the AWS Brazing Handbook, using copper-phosphorus brazing filler metal complying with the requirements specified in ANSI/AWS A5.8/A5.8M.
5. Threaded Joints:
 - a. Thread the pipe with tapered pipe threads in accordance with the requirements specified in ANSI/ASME B1.20.1.
 - 1) Cut the threads full and clean using sharp dies.
 - b. Ream the threaded pipe ends to remove burrs and restore the full inside diameter of the pipe.
 - c. Join the threaded pipe fittings and valves as follows:
 - 1) Unless dry seal threading is specified, apply appropriate tape or thread compound to the external pipe threads.
 - 2) Damaged Threads:
 - a) Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - b) Do not use pipe sections that have cracked or open welds.
6. Welded Joints:
 - a. Construct welded joints in accordance with the requirements specified in ANSI/AWS D10.12M/D10.12, using qualified processes and welding operators as specified in Subparagraph 1.05.A.2.
7. Flanged Joints:
 - a. Select gasket material of the size, type, and thickness appropriate for the service application.
 - b. Install the gasket so it is concentrically positioned.
 - c. Use suitable lubricants on the bolt threads and bolt the flanges together.
8. Fiberglass Bonded Joints:
 - a. Prepare fiberglass pipe ends and fittings, apply adhesive, and join the pipe and fittings in accordance with the fiberglass pipe manufacturer's installation instructions.
 - 1) Submit the fiberglass pipe manufacturer's written installation instructions to the Program/Project Manager for information.
9. Grooved Joints:



- a. Cut or roll grooves in the ends of the pipe based on the pipe and coupling manufacturer's instructions for the pipe wall thickness.
 - 1) Submit the grooved joint pipe and coupling manufacturer's written installation instructions for the pipe wall thickness to the Program/Project Manager for information.
- b. Assemble grooved joints using a coupling and gaskets, lubricant, and bolts.
- c. Provide grooved-end fittings, and rigid, grooved-end-pipe couplings.
- 10. Mechanically Formed, Copper-Tube-Outlet Joints:
 - a. In lieu of tee fittings in copper pipe, mechanically formed, copper-tube-outlet joints may be provided.
 - b. Join mechanically formed, copper-tube-outlet joints using the manufacturer-recommended tool and procedure, and braze the joints.
- 11. Pressure-Sealed Joints:
 - a. Provide pressure-sealed joints by using the manufacturer-recommended tool and procedure.
 - b. Leave the insertion marks on the pipe after assembly.

H. Hydronic Specialties:

- 1. Provide automatic air vents at the high points of system piping in mechanical equipment rooms only.
- 2. Provide manual vents at heat-transfer coils and elsewhere as required for venting air.
- 3. Install in-line air separators in pump suction lines.
 - a. For air separators having nominal pipe sizes of 2 inches (DN 50) and larger, provide a drain valve.
- 4. Provide bypass chemical feeders in each hydronic system at the locations indicated in the Contract Drawings, and in an upright position with the top of the funnel not more than 48 inches (1200mm) above the floor.
 - a. Install the chemical feeders in a bypass line having a nominal pipe size of at least 3/4 inch (DN 20), from the main; and having a full-size, full-port, ball valve in the main between the bypass connections.
 - b. Install a pipe having a nominal pipe size of at least 3/4 inch (DN 20) from the chemical feeder drain to the nearest equipment drain, and provide a full-size, full-port, ball valve in the drain line.
- 5. Install expansion tanks above the air separator.
 - a. Install the tank fitting in tank bottom and charge the tank.
 - b. To establish the proper water level in the tank, use the manual vent during the initial fill.
 - c. Install the tank fittings that are shipped loose.
 - d. Support the tank from the floor or from the structure above with supports having sufficient strength to carry the weight of the tank, piping connections, fittings, and the water filling a full tank.
 - 1) Do not overload building components and structural members.

I. Terminal Equipment Connections:



1. Size the supply and return piping connections the same as or larger than the equipment connections.
2. Install control valves in accessible locations close to the connected equipment.
3. Install bypass piping having a globe valve around the control valve.
 - a. If parallel control valves are installed, only one bypass is required.
4. Install ports for pressure gages and thermometers at the coil inlet and outlet connections in accordance with the requirements specified in Section 15122, Meters and Gages.

J. Special Techniques:

1. Chemical Treatment:

- a. Perform an analysis of the makeup water to determine the type and quantities of chemical treatment needed to keep the system free of scale, corrosion, and fouling; and to maintain the following water characteristics:
 - 1) pH: 9.0 to 10.5.
 - 2) "P" Alkalinity: 100 to 500 parts per million.
 - 3) Boron: 100 to 200 parts per million.
 - 4) Chemical Oxygen Demand: 100 parts per million maximum.
 - 5) Corrosion Inhibitor:
 - a) Sodium Nitrate: 1000 to 1500 parts per million.
 - 6) Soluble Copper: 0.20 parts per million maximum.
 - 7) Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: 10 parts per million minimum.
 - 8) Total Suspended Solids: 10 parts per million maximum.
 - 9) Ammonia: 20 parts per million maximum.
 - 10) Free Caustic Alkalinity: 20 parts per million maximum.
 - 11) Microbiological Limits:
 - a) Total Aerobic Plate Count: 1000 organisms per milliliter maximum.
 - b) Total Anaerobic Plate Count: 100 organisms per milliliter maximum.
 - c) Nitrate Reducers: 100 organisms per milliliter.
 - d) Sulfate Reducers: 0 organisms per milliliter maximum.
 - e) Iron Bacteria: 0 organisms per milliliter maximum.
- b. Fill the system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from the piping.
 - 1) Circulate the solution for a minimum of 24 hours; then drain the system, clean the strainer screens, and refill the system with fresh water.
- c. Add the initial chemical treatment and maintain the water quality within the ranges specified for the first year of operation.

K. Systems Integration:



1. Provide valves in accordance with the requirements specified in Section 1511, Valves.
2. Piping Identification:
 - a. Identify the piping in accordance with the requirements specified in Section 15075, Mechanical Identification.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Prepare hydronic piping for testing in accordance with the requirements specified in ASME B31.9 and as follows:
 - a. Leave joints, including welds, uninsulated and exposed for examination during the testing.
 - b. Provide temporary restraints for expansion joints that cannot sustain the reactions due to the test pressure.
 - 1) If temporary restraints are impractical, isolate the expansion joints from the testing.
 - c. Flush the hydronic piping systems with clean water; then remove and clean or replace the strainer screens.
 - d. Isolate equipment from the piping.
 - 1) If a valve is used to isolate the equipment, ensure that the valve closure is capable of sealing against the applied test pressure without damaging to valve.
 - 2) Install blinds in flanged joints to isolate equipment.
 - e. Install a safety valve, set at a pressure no more than one-third higher than the test pressure, to protect against damage by expanding liquid or another source of overpressure during the testing.
2. Hydrostatic Test:
 - a. Test Procedure:
 - 1) Use ambient temperature water as a testing medium unless there is risk of damage due to freezing.
 - a) Another liquid that is safe for workers and compatible with the piping may be used.
 - 2) Use the vents installed at the high points of the system to release air while filling system with the testing medium.
 - 3) Isolate the expansion tanks to determine and verify that the hydronic system is completely full of water.
 - 4) Subject piping system to a hydrostatic test pressure that is not less than 1.5 times the system's working pressure.
 - a) Do not allow the test pressure to exceed the maximum pressure for any vessel, pump, valve, or other component in system under test.
 - b) Verify that the stress due to the pressure at the bottom of vertical runs does not exceed 90 percent of the specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9.



- 5) After the hydrostatic test pressure has been applied for at least 10 minutes, examine the piping, joints, and connections for leakage.
 - 6) Use drains installed at low points to completely drain the test medium from the system.
 - 7) Prepare a written test report documenting the testing and submit these Hydrostatic Test Reports to the Program/Project Manager for information.
- b. Acceptance Criteria:
- 1) Leaks in the hydronic piping system are unacceptable.

B. Non-Conforming Work

1. Eliminate leaks by tightening, repairing, or replacing components, and repeat the hydrostatic test until there are no leaks.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

B. Perform the following actions before operating the system:

1. Fully open the manual valves.
2. Inspect the pumps for proper rotation.
3. Set the makeup pressure-reducing valves for the required system pressure.
4. Inspect the air vents at the high points of the system; and determine if the automatic types are installed and operating freely, and the manual types bleed air completely.
5. Set the temperature controls so all coils are calling for full flow.
6. Inspect and set the operating temperatures of the hydronic equipment, such as boilers, chillers, cooling towers, to the specified values.
7. Verify motors and bearings have been properly lubricated.

3.06 CLEANING

A. Waste Management:

1. Properly and legally dispose of excess water treatment chemicals.
2. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Protect installed hydronic piping from damage and wear during the remainder of the construction period.



3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data for the air control devices, hydronic specialties, and special-duty valves to the Program/Project Manager for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.
- B. Water-Treatment Chemicals:
 - 1. Furnish enough chemicals sufficient for the initial system startup, and for preventive maintenance for one year from the date of Substantial Completion.

3.09 DEMONSTRATION AND TRAINING

- A. The CONTRACTOR shall provide a minimum of four (4) hours of demonstration and training to Aviation Maintenance and Operations Personnel covering the following items:
 - 1. Field joint preparation and installation.
 - 2. Installation of field applied insulation.
 - 3. Installation and repair of HDPE and PVC jackets.
 - 4. Testing of installed field joints to ensure water tight installation.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	08/08/2018	RFI-0310	Edited 2.01.C.4. and 3.03.F; Added 3.03.A,B,C and 3.09.	Updated for underground chilled water piping.



SECTION 15186

REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for refrigerant piping used for air-conditioning applications.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 08311 - Access Doors and Frames.
 - 7. Section 15050 - Basic Mechanical Materials and Methods.
 - 8. Section 15060 - Hangers and Supports.
 - 9. Section 15075 - Mechanical Identification.
 - 10. Section 15900 - HVAC Instrumentation and Controls.
 - 11. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. GRC: Hot dipped galvanized rigid steel conduit.
 - 2. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
 - 3. PTFE: Polytetrafluoroethylene.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
 - 3. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in



29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.

C. Reference Standards:

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - a. ANSI/AHRI 495 – Standard for Performance Rating of Refrigerant Liquid Receivers.
 - b. ANSI/AHRI 730 – Standard for Flow-Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers.
 - c. ANSI/AHRI 750 – Standard for Thermostatic Refrigerant Expansion Valves.
 - d. ANSI/AHRI 760 – Standard for Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
2. American Society of Heating, Refrigerating and Air- Conditioning Engineers, Inc. (ASHRAE):
 - a. ASHRAE 15 – Safety Standard for Refrigeration Systems.
 - b. ASHRAE 34 – Designation and Safety Classification of Refrigerants.
3. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - b. ASME B31.5 – Refrigeration Piping and Heat Transfer Components.
 - c. ASME BPVC-IV - Boiler and Pressure Vessel Code - Section IV: Heating Boilers.
 - d. ASME BPVC-IX - Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.
4. ASTM International (ASTM):
 - a. ASTM B 32 - Standard Specification for Solder Metal.
 - b. ASTM B 280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - c. ASTM B 828 – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
5. American Welding Society (AWS):
 - a. ANSI/AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
 - b. AWS Brazing Handbook, 5th Edition.
6. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
7. Copper Development Association Inc. (CDA)
 - a. CDA A4015 - The Copper Tube Handbook.
8. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.



9. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.
10. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
11. Underwriters Laboratories, Inc. (UL):
 - a. UL 429 – UL Standard for Safety Electrically Operated Valves.
12. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the size and location of roof curbs, equipment supports, and roof penetrations.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Thermostatic expansion valves.
 - 2) Solenoid valves.
 - 3) Hot-gas bypass valves.
 - 4) Filter dryers.
 - 5) Strainers.
 - 6) Pressure-regulating valves.
 - b. Qualification Statements:
 - 1) Welding procedure specifications (WPS) test records.
 - 2) Welding Certificates.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Adjustments instructions.
 - b. Site Quality Control Submittals:
 - 1) Refrigerant Piping Test Reports.



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the refrigerant valves and piping specialties.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Welding Qualifications:

- a. Welding Procedure Specifications (WPS):
 - 1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
 - 2) For all procedures, other than those set forth in ASME BPVC-IX, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
- b. Welders' Qualifications:
 - 1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
 - 2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed for the procedures in ASME BPVC-IX.
 - 3) Submit Welding Certificates certifying the welders employed to fabricate and to erect the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Transport pipe materials and other products specified herein in a manner recommended by the respective manufacturers.



B. Storage and Handling Requirements:

1. Store and handle pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects from occurring.
2. Protect pipe from impact shocks and free fall during handling.
3. Store piping in a clean and protected area with end caps in place to ensure that interior and exterior of the piping are clean at the time of installation.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 REFRIGERANT PIPING SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

C. Performance:

1. Provide refrigerant piping capable of withstanding the refrigerant line test pressures specified in Table 15186-1 when conveying the refrigerants listed.

**Table 15186-1 Refrigerant Line Test Pressures**

Refrigerant	Suction Lines for Air- Conditioning Applications	Suction Lines for Heat-Pump Applications	Hot-Gas and Liquid Lines
R-134a	115 psig (793kPa)	225 psig (1551kPa)	225 psig (1551kPa)
R-407C	230 psig (1586kPa)	380 psig (2620kPa)	380 psig (2620kPa)
R-410A	300 psig (2068kPa)	535 psig (3689kPa)	535 psig (3689kPa)

D. Design Criteria:

1. The plans, schematics, and diagrams on the Contract Drawings indicate the general location and arrangement of the piping systems.
 - a. The locations and arrangements indicated were used to size the pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - b. Install piping as indicated on the Contract Drawings unless deviations to that layout have been approved on Shop Drawings.
2. Select system components having pressure ratings equal to or greater than the system operating pressure.
3. Provide refrigerant piping complying with the requirements specified in ASHRAE 15 and ASME B31.5.
 - a. Piping for Refrigerants R-134A, R-407C, and R-410A:
 - 1) Conventional Air-Conditioning Piping:
 - a) For conventional air-conditioning suction lines having nominal pipe sizes of 4 inches (DN 100) and smaller, provide Type ACR drawn-temper copper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2) Hot-Gas and Liquid Lines, and Heat-Pump Piping:
 - a) For hot-gas and liquid lines, and for heat-pump suction lines, provide Type ACR annealed-temper copper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3) Safety-Relief-Valve Discharge Piping:
 - a) For safety-relief-valve discharge piping, provide Type ACR drawn-temper copper tubing and wrought-copper fittings with soldered joints.
4. Product Data:



- a. Obtain the manufacturer's Product Data for each type of valve and refrigerant piping specialty in the following list, including the pressure drop for the item based on manufacturer's test data:
 - 1) Thermostatic expansion valves.
 - 2) Solenoid valves.
 - 3) Hot-gas bypass valves.
 - 4) Filter dryers.
 - 5) Strainers.
 - 6) Pressure-regulating valves.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- E. Operation:
 - 1. Operation Sequences:
 - a. The Sequence of Operation for the mechanical systems is indicated on the Contract Drawings.
- F. Materials:
 - 1. Copper Tube and Fittings:
 - a. Copper Tube:
 - 1) Provide copper tube complying with the requirements for Type ACR specified in ASTM B 280.
 - b. Wrought-Copper Fittings:
 - 1) Provide wrought-copper fittings complying with the requirements specified in ANSI/ASME B16.22.
 - c. Wrought-Copper Unions:
 - 1) Provide wrought-copper unions complying with the requirements specified in ANSI/ASME B16.22.
 - d. Solder Filler Metals:
 - 1) Provide solder filler metals complying with the requirements specified in ASTM B 32.
 - 2) To join copper socket fittings on copper pipe, provide 95-5 tin antimony or alloy HB solder.
 - e. Brazing Filler Metals:
 - 1) Provide brazing filler metals complying with the requirements specified in ANSI/AWS A5.8/A5.8M.
 - f. Flexible Connectors for Copper Tube and Fittings:
 - 1) For copper tube and fittings, provide flexible connectors having the following features and performance characteristics:
 - a) Body:



- (1) Provide flexible connectors having a body consisting of a tin-bronze bellows with a woven, flexible, tinned-bronze-wire-reinforced protective jacket.
- b) End Connections:
 - (1) Provide flexible connectors having socket ends.
- c) Offset Performance:
 - (1) Provide flexible connectors capable of misalignment in an assembly that is at least 7 inches (180mm) long of at least 3/4-inch (20mm).
- d) Pressure Rating:
 - (1) Provide flexible connectors that have been successfully factory-tested to pressures of at least 500 psig (3450kPa).
- e) Maximum Operating Temperature:
 - (1) Provide flexible connectors capable of operation at temperatures up to and including 250 degrees Fahrenheit (121 degrees Celsius).
- g. Flexible Connectors for Steel Pipe and Fittings:
 - 1) For steel pipe and fittings, provide flexible connectors having the following features and performance characteristics:
 - a) Body:
 - (1) Provide flexible connectors having a body consisting of a stainless-steel bellows with a woven, flexible, stainless-steel-wire-reinforced protective jacket.
 - b) End Connections:
 - (1) For nominal pipe sizes of 2 inches (DN 50) and smaller, provide flexible connectors having threaded-end connections.
 - (2) For nominal pipe sizes of 2-1/2 inches (DN 50) and larger, provide flexible connectors having flanged-end connections.
 - c) Offset Performance:
 - (1) Provide flexible connectors capable of misalignment in an assembly that is at least 7 inches (180mm) long of at least 3/4-inch (20mm).
 - d) Pressure Rating:
 - (1) Provide flexible connectors that have been successfully factory-tested to pressures of at least 500 psig (3450kPa).
 - e) Maximum Operating Temperature:
 - (1) Provide flexible connectors capable of operation at temperatures up to and including 250 degrees Fahrenheit (121 degrees Celsius).



2. Valves and Specialties:

a. Diaphragm Packless Valves:

- 1) Provide diaphragm packless globe valves having a straight-through or angle pattern, and the following features and performance characteristics:
 - a) Body and Bonnet:
 - (1) Provide valves having a forged brass or cast bronze body and bonnet.
 - b) Diaphragm:
 - (1) Provide valves having a phosphor bronze and stainless steel diaphragm with a stainless-steel spring.
 - c) Operator:
 - (1) Provide valves having a rising stem and hand wheel.
 - d) Seat:
 - (1) Provide valves having a nylon seat.
 - e) End Connections:
 - (1) Provide valves having socket, union, or flanged end connections.
 - f) Working Pressure Rating:
 - (1) Provide valves rated for a working pressure of 500 psig (3450kPa).
 - g) Maximum Operating Temperature:
 - (1) Provide valves rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).

b. Packed-Angle Valves:

- 1) Provide packed-angle valves having the following features and performance characteristics:
 - a) Body and Bonnet:
 - (1) Provide valves having a forged brass or cast bronze body and bonnet.
 - b) Packing:
 - (1) Provide valves having molded stem packing and back seating.
 - (a) Provide packing that is replaceable under pressure.
 - c) Operator:
 - (1) Provide valves having a rising stem operator.
 - d) Seat:
 - (1) Provide valves having a non-rotating, self-aligning polytetrafluoroethylene (PTFE) seat.
 - e) Seal Cap:



- (1) Provide valves having a forged-brass or valox hex seal cap.
- f) End Connections:
 - (1) Provide valves having socket, union, threaded, or flanged end connections.
- g) Working Pressure Rating:
 - (1) Provide valves rated for a working pressure of 500 psig (3450kPa).
- h) Maximum Operating Temperature:
 - (1) Provide valves rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).
- c. Check Valves:
 - 1) Provide check valves having the following features and performance characteristics:
 - a) Body:
 - (1) Provide check valves having a ductile iron, forged brass or cast bronze globe pattern body.
 - b) Bonnet:
 - (1) Provide check valves having a bolted ductile iron, forged brass or cast bronze bonnet, or having a brass hex plug.
 - c) Piston:
 - (1) Provide check valves having a piston with a removable polytetrafluoroethylene (PTFE) seat.
 - d) Closing Spring:
 - (1) Provide check valves having a stainless steel closing spring.
 - e) Manual Opening Stem:
 - (1) Provide check valves having a manual opening stem with a seal cap, a plated-steel stem, and a graphite seal.
 - f) End Connections:
 - (1) Provide check valves having socket, union, threaded, or flanged end connections.
 - g) Maximum Opening Pressure:
 - (1) Provide check valves requiring an opening pressure of not more than 0.50 psig (3.4kPa).
 - h) Working Pressure Rating:
 - (1) Provide check valves rated for a working pressure of 500 psig (3450kPa).
 - i) Maximum Operating Temperature:



- (1) Provide check valves rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).
- d. Service Valves:
 - 1) Provide service valves having the following features and performance characteristics:
 - a) Body:
 - (1) Provide service valves having a forged brass body with a brass cap including a key end for removing the core.
 - b) Core:
 - (1) Provide service valves having a removable ball-type check valve core with a stainless-steel spring.
 - c) Seat:
 - (1) Provide service valves having a polytetrafluoroethylene (PTFE) seat.
 - d) End Connections:
 - (1) Provide service valves having copper spring end connections.
 - e) Working Pressure Rating:
 - (1) Provide service valves rated for a working pressure of 500 psig (3450kPa).
- e. Solenoid Valves:
 - 1) Provide factory-mounted solenoid valves that comply with the requirements specified in ANSI/AHRI 760 and UL 429 as an integral part of the split-system cooling units, and that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL), and that have the following features and performance characteristics:
 - a) Body and Bonnet:
 - (1) Provide solenoid valves having a plated steel body and bonnet.
 - b) Solenoid Tube, Plunger, Closing Spring, and Seat Orifice:
 - (1) Provide solenoid valves having stainless steel solenoid tubes, plungers, closing springs, and seat orifices.
 - c) Seat:
 - (1) Provide solenoid valves having a polytetrafluoroethylene (PTFE) seat.
 - d) End Connections:
 - (1) Provide solenoid valves having threaded end connections.
 - e) Electrical:



- (1) Provide a molded, watertight, 24-Volt DC or 115-Volt AC coil mounted in an enclosure complying with the requirements for the location specified in NEMA 250, and a 1/2-inch (16-GRC) conduit adapter.
- f) Working Pressure Rating:
 - (1) Provide solenoid valves rated for a working pressure of 400 psig (2760kPa).
- g) Maximum Operating Temperature:
 - (1) Provide solenoid valves rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- h) Manual Operators:
 - (1) Provide manual operators for the solenoid valves.
- f. Safety Relief Valves:
 - 1) Provide safety relief valves that comply with the requirements specified in ASME BPVC-IV, that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL), and that have the following features and performance characteristics:
 - a) Body and Bonnet:
 - (1) Provide valves having a ductile iron and steel body and bonnet with neoprene O-ring seals.
 - b) Piston, Closing Spring, and Seat Insert:
 - (1) Provide valves having stainless steel pistons, closing springs, and seat inserts.
 - c) Seat Disc:
 - (1) Provide valves having a polytetrafluoroethylene (PTFE) seat disc.
 - d) End Connections:
 - (1) Provide valves having threaded end connections.
 - e) Working Pressure Rating:
 - (1) Provide valves rated for a working pressure of 400 psig (2760kPa).
 - f) Maximum Operating Temperature:
 - (1) Provide valves rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- g. Thermostatic Expansion Valves:
 - 1) Provide thermostatic expansion valves that comply with the requirements specified in ANSI/AHRI 750, and that have the following features and performance characteristics:
 - a) Body, Bonnet, and Seal Cap:



- (1) Provide thermostatic expansion valves having a forged brass or steel body, bonnet, and seal cap.
- b) Diaphragm, Piston, Closing Spring, and Seat Insert:
 - (1) Provide thermostatic expansion valves having stainless steel diaphragms, pistons, closing springs, and seat inserts.
- c) Packing and Gaskets:
 - (1) Provide thermostatic expansion valves having non-asbestos packing and gaskets.
- d) Capillary and Bulb:
 - (1) Provide thermostatic expansion valves having copper tubing capillary and bulb filled with a refrigerant charge.
- e) Suction Temperature:
 - (1) Provide thermostatic expansion valves rated for a suction temperature of 40 degrees Fahrenheit (4.4 degrees Celsius).
- f) Superheat:
 - (1) Provide thermostatic expansion valves adjustable to accommodate superheat.
- g) For heat-pump applications, provide thermostatic expansion valves designed for reverse-flow.
- h) End Connections:
 - (1) Provide valves having socket, flare, or threaded union end connections.
- i) Working Pressure Rating:
 - (1) Provide valves rated for a working pressure of 450 psig (3100kPa).
- h. Hot-Gas Bypass Valves:
 - 1) Provide hot-gas bypass valves that comply with the requirements specified in UL 429, that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL), and that have the following features and performance characteristics:
 - a) Body, Bonnet, and Seal Cap:
 - (1) Provide hot-gas bypass valves having a ductile iron or steel body, bonnet, and seal cap.
 - b) Diaphragm, Piston, Closing Spring, and Seat Insert:
 - (1) Provide hot-gas bypass valves having stainless steel diaphragms, pistons, closing springs, and seat inserts.
 - c) Packing and Gaskets:
 - (1) Provide hot-gas bypass valves having non-asbestos packing and gaskets.



- d) Solenoid Tube, Plunger, Closing Spring, and Seat Orifice:
 - (1) Provide hot-gas bypass valves having stainless steel solenoid tubes, plungers, closing springs, and seat orifices.
- e) Seat:
 - (1) Provide hot-gas bypass valves having a polytetrafluoroethylene (PTFE) seat.
- f) Equalizer:
 - (1) Provide hot-gas bypass valves having an internal equalizer.
- g) Electrical:
 - (1) Provide a molded, watertight, 115-Volt AC coil mounted in an enclosure complying with the requirements for the location specified in NEMA 250, and a 1/2-inch (16-GRC) conduit adapter.
- h) End Connections:
 - (1) Provide hot-gas bypass valves having socket end connections.
- i) Throttling Range:
 - (1) Provide hot-gas bypass valves having a maximum throttling range of 5 psig (34kPa).
- j) Working Pressure Rating:
 - (1) Provide valves rated for a working pressure of 500 psig (3450kPa).
- k) Maximum Operating Temperature:
 - (1) Provide valves rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- i. Straight-Type Strainers:
 - 1) Provide straight-type strainers that have the following features and performance characteristics:
 - a) Body:
 - (1) Provide straight-type strainers having welded steel bodies with a corrosion-resistant coating.
 - b) Screen:
 - (1) Provide straight-type strainers having 100-mesh stainless steel screens.
 - c) End Connections:
 - (1) Provide strainers having socket or flare end connections.
 - d) Working Pressure Rating:



- (1) Provide strainers rated for a working pressure of 500 psig (3450kPa).
- e) Maximum Operating Temperature:
 - (1) Provide strainers rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).
- j. Angle-Type Strainers:
 - 1) Provide angle-type strainers that have the following features and performance characteristics:
 - a) Body:
 - (1) Provide angle-type strainers having a forged brass or cast bronze body.
 - b) Drain Plug:
 - (1) Provide angle-type strainers having a brass hex drain plug.
 - c) Screen:
 - (1) Provide angle-type strainers having 100-mesh monel screens.
 - d) End Connections:
 - (1) Provide strainers having socket or flare end connections.
 - e) Working Pressure Rating:
 - (1) Provide strainers rated for a working pressure of 500 psig (3450kPa).
 - f) Maximum Operating Temperature:
 - (1) Provide strainers rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).
- k. Moisture/Liquid Indicators:
 - 1) Provide moisture/liquid indicators that have the following features and performance characteristics:
 - a) Body:
 - (1) Provide moisture/liquid indicators having a forged brass body.
 - b) Window:
 - (1) Provide moisture/liquid indicators having a replaceable, clear, fused glass window and a filter screen to protect the indicating element.
 - c) Indicator:
 - (1) Provide moisture/liquid indicators having a color coded indicator to show the moisture content in ppm.
 - d) Minimum Moisture Indicator Sensitivity:



- (1) Provide moisture/liquid indicators capable of indicating moisture above 60 ppm.
- e) End Connections:
 - (1) Provide moisture/liquid indicators having socket or flare end connections.
- f) Working Pressure Rating:
 - (1) Provide moisture/liquid indicators rated for a working pressure of 500 psig (3450kPa).
- g) Maximum Operating Temperature:
 - (1) Provide moisture/liquid indicators rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- I. Replaceable-Core Filter Dryers:
 - 1) Provide replaceable-core filter dryers that comply with the requirements specified in ANSI/AHRI 730, and that have the following features and performance characteristics:
 - a) Body and Cover:
 - (1) Provide replaceable-core filter dryers having a painted-steel shell with a ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 - b) Filter Media:
 - (1) Provide replaceable-core filter dryers having 10 micron, pleated filter media with integral end rings, and a stainless-steel support.
 - c) Desiccant Media:
 - (1) Provide replaceable-core filter dryers having activated alumina desiccant.
 - d) For heat-pump applications, provide replaceable-core filter dryers designed for reverse-flow.
 - e) End Connections:
 - (1) Provide replaceable-core filter dryers having socket end connections.
 - f) Access Ports:
 - (1) For suction-line filter dryers, provide replaceable-core filter dryers having 1/4 inch (DN 8) nominal pipe size connections at both the entering and leaving sides for pressure differential measurement.
 - g) Maximum Pressure Loss:
 - (1) Provide replaceable-core filter dryers having a maximum pressure loss of 2 psig (14kPa).
 - h) Rated Flow:



- (1) Provide replaceable-core filter dryers rated for the flow scheduled on the Contract Drawings.
- i) Working Pressure Rating:
 - (1) Provide replaceable-core filter dryers rated for a working pressure of 500 psig (3450kPa).
- j) Maximum Operating Temperature:
 - (1) Provide replaceable-core filter dryers rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
- m. Permanent Filter Dryers:
 - 1) Provide permanent filter dryers that comply with the requirements specified in ANSI/AHRI 730, and that have the following features and performance characteristics:
 - a) Body and Cover:
 - (1) Provide permanent filter dryers having a painted-steel shell.
 - b) Filter Media:
 - (1) Provide permanent filter dryers having 10 micron, pleated filter media with integral end rings, and a stainless-steel support.
 - c) Desiccant Media:
 - (1) Provide permanent filter dryers having activated alumina desiccant.
 - a) For heat-pump applications, provide permanent filter dryers designed for reverse-flow.
 - b) End Connections:
 - (1) Provide permanent filter dryers having socket end connections.
 - c) Access Ports:
 - (1) For suction-line filter dryers, provide permanent filter dryers having 1/4 inch (DN 8) nominal pipe size connections at both the entering and leaving sides for pressure differential measurement.
 - d) Maximum Pressure Loss:
 - (1) Provide permanent filter dryers having a maximum pressure loss of 2 psig (14kPa).
 - e) Rated Flow:
 - (1) Provide permanent filter dryers rated for the flow scheduled on the Contract Drawings.
 - f) Working Pressure Rating:



- (1) Provide permanent filter dryers rated for a working pressure of 500 psig (3450kPa).
 - g) Maximum Operating Temperature:
 - (1) Provide permanent filter dryers rated for a maximum operating temperature of 240 degrees Fahrenheit (116 degrees Celsius).
 - n. Liquid Accumulators:
 - 1) Provide liquid accumulators that comply with the requirements specified in ANSI/AHRI 495, and that have the following features and performance characteristics:
 - a) Body:
 - (1) Provide liquid accumulators having welded steel bodies with a corrosion-resistant coating.
 - b) End Connections:
 - (1) Provide liquid accumulators having socket or threaded end connections.
 - c) Working Pressure Rating:
 - (1) Provide liquid accumulators rated for a working pressure of 500 psig (3450kPa).
 - d) Maximum Operating Temperature:
 - (1) Provide liquid accumulators rated for a maximum operating temperature of 275 degrees Fahrenheit (135 degrees Celsius).
- 3. Refrigerants:
 - a. Provide the following refrigerants where indicated on the Contract Drawings:
 - 1) R-134a
 - a) Provide R-134a refrigerant complying with the requirements for tetrafluoroethane specified in ASHRAE 34.
 - 2) R-407C
 - a) Provide R-407C refrigerant complying with the requirements for difluoromethane/pentafluoroethane/1,1,1,2-tetrafluoroethane specified in ASHRAE 34.
 - 3) R-410A
 - a) Provide R-410A refrigerant complying with the requirements for pentafluoroethane/difluoromethane specified in ASHRAE 34.
 - b. Manufacturers:
 - 1) DuPont Company; Fluorochemicals Div,
http://www2.dupont.com/Directories/en_RU/Products_Services_Index/Chemicals/Fluorochemicals.html.



- 2) Honeywell, Inc.; Genetron Refrigerants, www51.honeywell.com.
- 3) INEOS Fluor Americas LLC, <https://www.ineos.com/>.
- 4) Approved equal.

2.02 ACCESSORIES

A. Hangers and Supports:

1. Provide hanger, support, and anchor products complying with the requirements specified in Section 15060, Hangers and Supports.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Examine the elements and surfaces to receive refrigerant piping for compliance with the installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Evaluation and Assessment:

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the refrigerant piping.

B. Surface Preparation:

1. For piping penetrations of walls, ceilings, and floors, install sleeves.

C. Demolition/Removal:

1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

A. Hangers and Supports:

1. For individual horizontal runs less than 20 feet (6m) long, provide adjustable steel clevis hangers.
2. For individual horizontal runs 20 feet (6m) or longer, provide roller hangers and spring hangers.



3. For multiple horizontal piping 20 feet (6m) or longer, provide Type 44 pipe rollers complying with the requirements specified in MSS SP-58 supported on a trapeze.
4. To support vertical runs, provide spring hangers.
5. For hangers and supports in direct contact with copper pipe, provide copper-clad hangers and supports.
6. Install hangers for copper tubing at the spacing and having the rod sizes specified in Table 15186-1:

Table 15186-2 Spacing and Rod Sizes for Copper Tubing Hangers		
Nominal Pipe Size (inches)	Maximum Span	Minimum Rod Size
1/2 (DN 15)	5 feet (1.5m)	1/4 inch (6.4mm)
5/8 (DN 18)	5 feet (1.5m)	1/4 inch (6.4mm)
1 (DN 25)	6 feet (1.8m)	1/4 inch (6.4mm)
1-1/4 (DN 32)	8 feet (2.4m)	3/8 inch (9.5mm)
1-1/2 (DN 40)	8 feet (2.4m)	3/8 inch (9.5mm)
2 (DN 50)	8 feet (2.4m)	3/8 inch (9.5mm)
2-1/2 (DN 65)	9 feet (2.7m)	3/8 inch (9.5 mm)

7. Support multi-floor vertical runs at least at each floor.

B. Piping:

1. Install the refrigerant piping in accordance with the requirements specified in ASHRAE 15.
2. Except in equipment rooms and service areas, install piping in concealed locations unless otherwise indicated in the Contract Documents.
 - a. Install the piping that is indicated to be exposed and the piping in equipment rooms and service areas at right angles or parallel to the building walls.
 - 1) Diagonal runs are prohibited unless specifically indicated otherwise in the Contract Documents.
 - b. When piping is installed above accessible ceilings, allow sufficient space to remove the ceiling panel.
3. When piping is installed adjacent to machines, allow space for service and maintenance.
4. Install piping free of sags and bends.
5. At changes in direction and branch connections, install fittings.



6. Install piping runs as short and as direct as possible, with the minimum number of joints, elbows, and fittings.
7. Arrange piping to allow inspection and service of refrigeration equipment.
 - a. Install valves and specialties in accessible locations to allow for service and inspection.
 - b. If valves or equipment requiring maintenance is concealed behind finished surfaces, install access doors or panels in accordance with the requirements specified in Section 08311, Access Doors and Frames.
8. Where refrigerant piping is installed belowground, provide protective conduit.
9. In locations where refrigerant piping is exposed to mechanical injury, install the refrigerant piping in rigid or flexible conduit.
10. Slope the refrigerant piping as follows:
 - a. Install horizontal hot-gas discharge piping with a uniform slope downward away from the compressor.
 - b. Install horizontal suction lines with a uniform slope downward to the compressor.
 - c. To entrain oil in vertical runs, install traps and double risers.
 - d. Liquid lines may be installed level.
11. When brazing or soldering, remove solenoid-valve coils and sight glasses, valve stems, seats, packing, and accessible internal parts of refrigerant specialties.
 - a. Do not apply heat near expansion-valve bulbs.
12. Before installing steel refrigerant piping, clean the pipe and fittings using the following procedures:
 - a. Shot blast the interior of the piping.
 - b. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing using a wire or electrician's tape.
 - c. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe.
 - 1) Continue this procedure until the cloth is not discolored by dirt.
 - d. Draw a clean, lintless cloth, saturated with compressor oil and then squeezed dry, through the tube or pipe to remove the remaining lint.
 - 1) Inspect the tube or pipe visually for remaining dirt and lint.
 - e. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - f. Safety-relief-valve discharge piping is not required to be cleaned, but is required to be open to allow unrestricted flow.
13. Install piping so there is adequate clearance between the pipe and the adjacent walls and hangers, and between pipes to allow insulation to be installed.



14. Identify refrigerant piping and valves in accordance with the requirements specified in Section 15075, Mechanical Identification.
15. For piping penetrations of walls, ceilings, and floors, install sleeves and escutcheons complying with the requirements for sleeves and escutcheons specified in Section 15050, Basic Mechanical Materials and Methods.
16. For piping penetrations of exterior concrete walls and slabs, install sleeve seals complying with the requirements for sleeve seals specified in Section 15050, Basic Mechanical Materials and Methods.

C. Pipe Joints:

1. Ream the ends of pipes and tubes and to remove burrs.
2. Bevel the plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from the inside and outside of the pipe and fittings before assembly.
4. To prevent scale formation during brazing or welding of steel pipe, fill the steel pipe and fittings with an inert gas such as nitrogen or carbon dioxide.
5. Soldered Joints:
 - a. Construct soldered joints in accordance with the requirements specified in ASTM B 828 or CDA A4015.
6. Brazed Joints:
 - a. Construct brazed joints in accordance with the requirements specified in the "Pipe and Tube" Chapter of the AWS Brazing Handbook, 5th Edition.
 - b. For joining copper socket fittings with copper pipe, provide Type BcuP, copper-phosphorus alloy.
 - c. For joining copper with bronze or steel, provide Type BAg, cadmium-free silver alloy.

D. Valves and Specialties:

1. Install diaphragm packless or packed-angle valves in the suction and discharge lines of the compressor.
2. Install service valves for gage taps at both the inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of the valves and strainers.
3. If compressor suction line will be exposed to air temperatures less than 75 degrees Fahrenheit (24 degrees Celsius) during compressor operation, install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
4. Unless otherwise indicated in the Contract Documents, install diaphragm packless or packed-angle valves on both the inlet and outlet side of filter dryers.



5. Install a full-sized, three-valve bypass around the filter dryers.
6. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve.
 - a. For solenoid valves in horizontal lines, install the valves with the coil at the top.
7. Install thermostatic expansion valves as close as possible to the distributors on evaporators.
 - a. Install the valve so the diaphragm case is warmer than bulb.
 - b. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps.
 - 1) Do not mount the bulb in a trap or at the bottom of the line.
 - c. If external equalizer lines are required, make the connection where it will reflect the suction-line pressure at the bulb location.
8. Install safety relief valves wherever required by ASME BPVC-IV.
 - a. Pipe the safety-relief-valve discharge line to the outside in accordance with the requirements specified in ASHRAE 15.
9. Install moisture/liquid indicators in the liquid line at the inlet of the thermostatic expansion valve, or at the inlet of the evaporator coil capillary tube.
10. Install strainers upstream from and adjacent to the following items unless they are furnished as an integral assembly for the device being protected:
 - a. Solenoid valves.
 - b. Thermostatic expansion valves.
 - c. Hot-gas bypass valves.
 - d. Compressors.
11. Install filter dryers in the liquid line between the compressor and the thermostatic expansion valve, and in the suction line at the compressor.
12. Install receivers sized to accommodate the pump-down charge.
13. Install flexible connectors at the compressors.

E. Systems Integration:

1. For solenoid valve controllers and control wiring, comply with the requirements specified in Section 15900, HVAC Instrumentation and Controls.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Refrigerant Piping Test:
 - a. Test Procedure:
 - 1) Perform testing in compliance with the requirements specified in Chapter VI of ASME B31.5.



- 2) Test refrigerant piping, specialties, and receivers.
 - a) Isolate compressor, condenser, evaporator, and safety devices from the test pressure if they are not rated above the test pressure.
 - 3) Test high- pressure and low-pressure side piping of each system separately at not less than the pressures indicated in Paragraph 2.01.C.
 - a) Fill the system with nitrogen to the required test pressure.
 - b) The system must maintain the test pressure at the manifold gage for the duration of test.
 - c) Test the joints and fittings using an electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - 4) Prepare a written test report documenting the testing, and submit these Refrigerant Piping Test Reports to the Program/Project Manager for information.
- b. Acceptance Criteria:
- 1) Leaking joints are unacceptable.

B. Non-Conforming Work

1. Remake leaking joints using new material, and retest the remade joints until satisfactory results are achieved.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

B. System Charging:

1. Charge the refrigerant piping system using the following procedure:
 - a. Install the core in the filter dryers after the leak test, but before evacuation.
 - b. Evacuate the entire refrigerant system using a vacuum pump to 500 micrometers (67Pa).
 - 1) If vacuum the holds for 12 hours, the system is ready for charging.
 - c. Break the vacuum using refrigerant gas, allowing the pressure to build up to 2 psig (14kPa).
 - d. Charge the system using a new filter-dryer core in the charging line.



3.06 ADJUSTING

- A. Submit the manufacturer's written adjustments instructions to the Program/Project Manager for information.
- B. Adjust adjustable thermostatic expansion valves to obtain the proper evaporator superheat.
- C. Adjust the high- pressure and low-pressure switch settings to prevent short cycling in response to fluctuating suction pressures.
- D. Adjust the set-point temperature of the air-conditioning or chilled-water controllers to the system design temperature.
- E. Before operating the refrigeration system, perform the following adjustments in accordance with the manufacturer's written instructions:
 - 1. Open the shutoff valves in the condenser water circuit.
 - 2. Verify that the compressor oil level is correct.
 - 3. Open the compressor suction and discharge valves.
 - 4. Open the refrigerant valves, except bypass valves, that are used for other purposes.
 - 5. Check the open compressor-motor alignment, and verify that the motors and bearings have been properly lubricated.
- F. After the system has been adjusted and after the design flow rates and pressures are established, replace the core of the replaceable filter dryer.

3.07 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 PROTECTION

- A. Protect installed refrigerant piping from damage and wear during the remainder of the construction period.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data for the refrigerant valves and piping specialties to the Program/Project Manager for inclusion in



emergency and Operation and Maintenance Manuals as specified in
Section 01780, Closeout Submittals.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15187

HEATING & COOLING PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of heating and cooling pumps:
 - a. Close-coupled, in-line centrifugal pumps.
 - b. Automatic condensate pump units.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 – Commissioning.
 - 6. Section 15060 - Hangers and Supports.
 - 7. Section 15065 - Motors for Mechanical Equipment.
 - 8. Section 15070 - Mechanical Sound, Vibration, and Seismic Controls.
 - 9. Section 15065 - Motors for Mechanical Equipment.
 - 10. Section 15995 - Commissioning of Mechanical Systems.
 - 11. Section 16061 - Electrical Grounding and Bonding.
 - 12. Section 16120 - Conductors and Cables.

1.02 REFERENCES

- A. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. Hydraulic Institute (HI):
 - a. ANSI/HI 1.1-1.2 – American National Standard for Centrifugal Pumps for Nomenclature and Definitions.



- b. ANSI/HI 1.3 – American National Standard for Rotodynamic (Centrifugal) Pumps for Design and Application.
- c. ANSI/HI 1.4 – American National Standard for Centrifugal Pumps for Installation, Operation, and Maintenance.
- 4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
- 6. Underwriters Laboratories, Inc. (UL):
 - a. UL 778 – Standard for Motor-Operated Water Pumps.
 - b. UL Online Certifications Directory, <http://wwwu.com/regulators>.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Hydronic heating and cooling pumps.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) Hydronic heating and cooling pumps.
 - 3) Wiring diagrams for the hydronic heating and cooling pumps.

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Pump and coupling manufacturers' written instructions for aligning the pump and motor shafts and the piping connections.



C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Pumps.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish the following spare parts matching the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Mechanical Seals:
 - (1) Furnish 1 mechanical seal for each pump provided as the Work of this Section.

1.05 QUALITY ASSURANCE

A. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Manufacturer's Preparation for Shipping Motors:



- a. Clean flanges and exposed machined metal surfaces, and treat them with an anticorrosion compound after assembly and testing.
 - b. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Storage and Handling Requirements:
 - 1. Store the pumps in a dry location.
 - 2. During storage, retain protective covers on flanges and protective coatings.
 - 3. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
 - 4. Comply with the pump manufacturer's rigging instructions.
 - a. Submit the pump manufacturer's written rigging instructions to the Program/Project Manager for approval.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 HEATING AND COOLING PUMP EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain heating and cooling pumps, components, and accessories within the same product category from a single source from a single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):



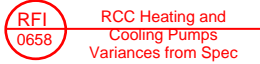
- 1) Provide products and installation complying with the requirements specified for enclosed switches and circuit breakers in NFPA 70.
- C. Performance:
 1. Pump Capacities and Characteristics:
 - a. Provide hydronic heating and cooling pumps having the capacities, characteristics, and accessories indicated in the Mechanical Equipment Schedule on the Contract Drawings.
- D. Design Criteria:
 1. Hydronic Heating and Cooling Pumps:
 - a. The Contract Drawings indicate the general arrangement of hydronic heating and cooling pumps.
 - 1) Plans, schematics, and diagrams included in the Contract Drawings indicate the sizes, profiles, and/or dimensional requirements of the hydronic heating and cooling pumps based on the specific system indicated in the Contract Documents.
 - 2) The indicated locations and arrangements may need to be modified based on the specific system provided and other design considerations.
 - 3) Install the hydronic heating and cooling pumps as indicated unless deviations to the installation are approved by the Program/Project Manager on Coordination Drawings.
 - b. Provide motor-operated water pumps designed in accordance with the requirements specified in UL 778.
 - c. Motors:
 - 1) Provide motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment.
 - d. Product Data:
 - 1) Obtain Product Data for the hydronic heating and cooling pumps that includes certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and the accessories for each type of product indicated.
 - a) Indicate the pump's operating point on the curves.
 - 2) Submit the Product Data for the hydronic heating and cooling pumps to the Program/Project Manager for approval.
 - e. Shop Drawings:
 - 1) Prepare Shop Drawings for the hydronic heating and cooling pumps that show the pump layout and connections.
 - a) Include setting drawings with templates for installing the foundation and anchor bolts and other anchorages.
 - 2) Prepare wiring diagrams showing the power, signal, and control wiring.



- 3) Submit the Shop Drawings and wiring diagrams for the hydronic heating and cooling pumps to the Program/Project Manager for approval.

E. Materials:

1. Close-Coupled, In-Line Centrifugal Pumps:
 - a. Provide factory-assembled and factory-tested, overhung-impeller, close-coupled, in-line centrifugal pumps as defined and specified in ANSI/HI 1.1-1.2 and ANSI/HI 1.3; and designed for installation with pump and motor shafts mounted horizontally or vertically.
 - b. Pump Rating:
 - 1) Provide pumps rated for a minimum working pressure of 175 psig (1204kPa), and a continuous water temperature of 200 degrees Fahrenheit (93 degrees Celsius).
 - c. Pump Construction:
 - 1) Casing:
 - a) Provide pumps having a radially split, cast iron casing with replaceable bronze wear rings, threaded gage tappings at the inlet and outlet, and threaded companion-flange connections.
 - 2) Impeller:
 - a) Provide pumps having a cast bronze impeller cast in accordance with the requirements specified in ASTM B 584; and statically and dynamically balanced, keyed to the pump shaft, and secured with a locking cap screw.
 - b) Trim the impeller to match the specified performance.
 - 3) Pump Shaft:
 - a) Provide pumps having a stainless steel pump shaft.
 - 4) Packing Seal:
 - a) Provide pumps having a stuffing box having a minimum of 4 rings of graphite-impregnated braided yarn with a bronze lantern ring between center two graphite rings, and a bronze packing gland.
 - 5) Pump Bearings:
 - a) Provide pumps having oil-lubricated, bronze-journal or thrust type pump bearings.
 - d. Motor:
 - 1) Unless otherwise indicated in the Contract Documents, provide pumps having a single speed motor complying with the requirements specified in Section 15065, Motors for Mechanical Equipment, rigidly mounted to the pump casing, and having grease-lubricated ball bearings.
 - e. Manufacturers:
 - 1) Armstrong Pumps Inc., <http://www.armstrongpumps.com>.
 - 2) Bell & Gossett; Division of ITT Corporation, <http://www.bellgossett.com>.



Per 0658, the spec variances noted in the submittal are acceptable



- 3) Grundfos Pumps Corporation, <http://www.grundfos.us>.
- 4) PACO Pumps,
<http://www.pacopumps.com/homepages/PacoHome.asp>.
- 5) Taco, Inc., <http://www.taco-hvac.com>.
- 6) Approved equal.
2. Automatic Condensate Pump Units:
 - a. Provide packaged units complete with a corrosion-resistant pump, a plastic tank with a cover, and automatic controls.
 - 1) Include a factory-installed or field-installed check valve, and an electrical power cord at least 72 inches long (1800mm) with a plug.
 - b. Manufacturers:
 - 1) Aurora Pump, Division of Pentair Pump Group,
<http://www.aurorapump.com>.
 - 2) Beckett Corporation, <http://www.beckettpumps.com>.
 - 3) Flowserve Corporation, Div. of Ingersoll-Dresser Pumps,
<http://www.flowserve.com>.
 - 4) Hartell Pumps Div., Milton Roy Co., <http://www.hartell.com>.
 - 5) Little Giant Pump Co., Subsidiary of Tecumseh Products Co.,
<http://www.lgpc.com>.
 - 6) Marshall Engineered Products Company (MEPCO),
<http://www.mepcolc.com>.
 - 7) Approved equal.
3. Pump Specialty Fittings:
 - a. Suction Diffusers:
 - 1) Provide angle pattern suction diffusers having a 175 psig (1204kPa) pressure rating, a cast-iron body and end cap, a pump-inlet fitting, bronze startup and bronze or stainless-steel permanent strainers, bronze or stainless-steel straightening vanes, a drain plug, and a factory-fabricated support.
 - b. Triple-Duty Valves:
 - 1) Provide angle or straight pattern triple-duty valves having a 175 psig (1204kPa) pressure rating, a cast-iron body, a pump-discharge fitting, a drain plug, and having bronze-fitted shutoff, balancing, and check valve features.
 - a) For flow measurement, provide brass gage ports having an integral check valve and an orifice.

2.02 ACCESSORIES

- A. Hangers and Supports:
 1. Provide hanger and support materials complying with the requirements specified in Section 15060, Hangers and Supports.
- B. Vibration Isolation Devices:



1. Provide vibration isolation devices complying with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Controls.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine equipment foundations and anchor-bolt locations to verify compliance with installation tolerances and requirements, and other conditions affecting the performance of the Work.
 2. Before installing the pumps, examine the rough-in for piping systems to verify the actual locations of the piping connections.
 3. Examine the foundations and walls where pumps are to be installed to verify that conditions are suitable.
- B. Evaluation and Assessment:
 1. Proceed to install the pumps only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the heating and cooling pumps.
- B. Surface Preparation:
 1. Install continuous-thread hanger rods and spring hangers having a vertical-limit stop of sufficient size to support the pump weight.

3.03 INSTALLATION

- A. Pumps:
 1. Install pumps in accordance with the requirements specified in ANSI/HI 1.4.
 2. Install pumps so access for periodic maintenance has been provided, including for the removal of motors, impellers, couplings, and accessories.
 3. Support pumps and piping independently so the weight of piping is not supported by the pumps, and the weight of pumps is not supported by piping.
 - a. Provide fabricated brackets and supports as required.
 - b. Suspend vertically mounted, in-line centrifugal pumps independent of their piping.
 4. Install the pumps on the hanger rods and spring hangers so their motors and pump shafts are vertical.



- B. Automatic Condensate Pump Units:
 - 1. For collecting condensate, install automatic condensate pump units, and extend their piping to an open drain.
- C. Alignment:
 - 1. After setting the pumps on their foundations, and the grout has been set, the foundation bolts have been tightened, and piping connections have been made, align the pump and motor shafts and the piping connections in accordance with the pump and coupling manufacturers' instructions.
 - a. Submit the pump and coupling manufacturers' written instructions for aligning the pump and motor shafts and the piping connections to the Program/Project Manager for information.
 - 2. Use the methods specified in ANSI/HI 1.3 to adjust the angular and offset alignment of the pump and motor shafts.
- D. Connections:
 - 1. To connect piping to pumps, install valves that are the same size as the piping connected to the pumps.
 - a. Install suction and discharge pipes having sizes equal to or greater than the diameter of the pump nozzles.
 - b. On the discharge side of each pump, install a triple-duty valve.
 - c. On the suction side of each pump, install a suction diffuser and a shutoff valve.
 - 2. Base-Mounted Pumps:
 - a. On the suction and discharge sides of base-mounted pumps, install flexible connectors between the pump casing and the valves.
 - 3. Automatic Condensate Pump Units:
 - a. On each condensate pump unit discharge, install a check valve and a ball valve.
- E. Special Techniques:
 - 1. Pressure Gages:
 - a. At integral pressure-gage tapings on the pump suction and discharge lines, install a pressure gage; or install a single gage having a multiple input selector valve.
- F. Systems Integration:
 - 1. Piping Connections:
 - a. Install piping in accordance with the requirements specified in other Sections where the piping is specified.
 - 1) Install piping adjacent to the machines to allow room for servicing and maintaining the equipment.
 - 2. Electrical Connections:
 - a. Connect wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.
 - 1) Install electrical connections for power, controls, and devices.



- b. Ground the pump equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.

3.04 SYSTEM STARTUP

- A. Commissioning:
 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping system, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.
- B. Engage a factory-authorized service representative to perform the startup service.
 1. Complete the installation and startup checks in accordance with the manufacturer's written instructions.
 2. Check the piping connections for tightness.
 3. Clean the strainers on the suction piping.
 4. Perform the following startup checks for each pump before starting the pump:
 - a. Verify bearing have been properly lubricated.
 - b. Verify that the pump is free to rotate by hand, and that pumps for handling hot liquid are free to rotate with the pump hot and cold.
 - 1) If the pump is bound or drags, do not operate it until the cause of the trouble is determined and corrected.
 - c. Verify that the pump is rotating in the correct direction.
 5. Prime the pump by opening the suction valves and closing the drains, and prepare the pump for operation.
 6. Start the pump motor.
 7. Open the discharge valve slowly.

3.05 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 CLOSEOUT ACTIVITIES

- A. Training:
 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the hydronic heating and cooling pumps in accordance with the requirements specified in Section 01770, Closeout Procedures.



3.07 PROTECTION

- A. Protect installed hydronic heating and cooling pumps from damage and wear during the remainder of the construction period.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
1. Submit operation and maintenance data for the hydronic heating and cooling pumps to the Program/Project Manager for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	04/05/2018	N/A	2.01.E	Corrected several web addresses.





SECTION 15188

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of Contract," "Special Conditions" and "Division 1 – General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. System cleaner.
 - 2. Closed system treatment: Chilled water.
 - 3. Steam system treatment.
 - 4. Condenser water system treatment.
 - 5. Open system treatment.
 - 6. Chemical feeder equipment including associated feeders, pumps, tanks, controls, meters and valves.
 - 7. Test equipment.
 - 8. Water Filtration Sand
 - a. Chilled water
 - b. Condenser water
- B. Related Sections:
 - 1. Section 15065 – Motors for Mechanical Equipment: Product requirements for motors for placement by this section.
 - 2. Division 16 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.03 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.04 PERFORMANCE REQUIREMENTS

- A. Provide system to treat water available at project site to maintain characteristics of water in closed, steam and open systems appropriate to each system as recommended by Water Treatment manufacturer.



1.05 SUBMITTALS

- A. Shop Drawings: Indicate dimensions, system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- B. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.06 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- B. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations. Also include instructions for operation and maintenance, cleaning, and unit schematic diagrams.

1.07 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Pennsylvania Department of Environmental Protection standard for addition of non-potable chemicals to building systems and for discharge to public sewers.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience, and with service facilities within 100 miles of Project with their own water analysis laboratories and full-time service personnel.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.



1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 MAINTENANCE SERVICE

- A. Furnish technical service visits, twice a month, for one year starting at Date of Substantial Completion, to perform field inspections and make water analysis of each system on site. Detail findings in writing on proper practices, chemical treating requirements and corrective actions needed. Submit two copies of field service report after each visit. Prior to each visit, contractor will provide advance notice of 48 hours as to the time and date of the next service visit. This ensures that microbiological dual assay slides for tower and chilled water systems will have adequate time to develop for discussion. At the close of each service visit, contractor will provide an electronic service report documenting the results of that service visit, actions taken, and any support required from staff to resolve open issues.
- B. Perform monthly testing of cooling tower water for legionella pneumophila. Submit report stating bacteria count per milliliter and results from previous test.
- C. Furnish laboratory and technical assistance services during this maintenance period.
- D. Furnish on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections. Contractor will physically inspect heat exchangers, boilers and chillers annually to document the condition of this equipment. A detailed report will be provided to owner for each inspection completed.

1.11 MAINTENANCE MATERIALS

- A. Furnish chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.01 SYSTEM CLEANER

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.



- B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
- C. Biocide.

2.02 CLOSED SYSTEM TREATMENT (WATER)

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Molybdate product can be used at (100-150 PPM), OR Nitrite at (400-800PPM- Chilled Water and 800-1000 PPM Hot Water)
- C. Chilled Water Biocide - Chilled water systems will be treated (4) times per year with a non-oxidizing biocide (gluteraldehyde) treatment.
- D. Bacteria levels must be less than 100 CFU's at all times.
- E. Bypass bag filter feeder is required: FTF-5DB
- F. Azole must be > 10 ppm at all times to protect yellow metals.

2.03 CONDENSER WATER SYSTEM TREATMENT (COOLING TOWERS)

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc Water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Corrosion/Scale Inhibitor –
 - 1. Organic based program with supported by a polymer (for calcium phosphate stabilization), phosphonate/PBTC (for calcium carbonate stabilization and additional corrosion protection) and azole (tolytriazole or benzotriazole).
 - 2. The products and control ranges have been specified in the bid forms.
 - 3. Product will provide a minimum of 5 ppm of phosphonate (PBTC), 25 ppm of polymer (for calcium phosphate inhibition) and 3 ppm of azole in the cooling tower.
- C. Cooling tower oxidizing biocide



1. Liquid stabilized bromine-based chemistry.
 2. Product will be fed to achieve a minimum of 1 ppm free residual chlorine for a minimum of 1 hour.
- D. Cooling tower non-oxidizing biocide – please select a gluteraldehyde based biocide. Product will be fed (2) times per week at 120 ppm.
- E. Bacteria levels must be maintained at less than 10,000 CFU's at all times.

2.04 BY-PASS (POT) FEEDER

- A. Manufacturers:
1. Neptune
 2. Water Treatment by Design (WTBD)
 3. Arc Water Treatment
 4. Barclay Water Management
 5. Klenzoid
 6. Or equal as approved by the Professional.
- B. 5-gallon filter/feeder with legs includes body and basket, bag, 1-micron, quick opening cap for working pressure of 300 psig.

2.05 SOLUTION METERING PUMP

- A. Manufacturers:
1. LMI Milton Roy
 2. Lutz Jesco America Corp.
 3. Neptune Pump Company
 4. Walchem
 5. Or equal as approved by the Professional.
- B. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.
- C. Electrical Characteristics:
1. 120 volts, single phase, 60 Hz.
 2. Cord and Plug: Furnish unit with 6-foot cord and plug for connection to electric wiring system including grounding connector.

2.06 CORROSION COUPONS

- A. Provide mild steel and copper corrosion coupons for each system having a corrosion coupon rack. Coupon racks shall be provided for any systems that do not currently have this equipment in place. Analyze one (1) set of copper and steel corrosion coupons on a 90-day schedule for open condenser systems and a 180-day schedule for -loop systems. Both pitting and general corrosion rates shall be reported. The coupon report shall contain photographs



of the coupon as removed from the rack and after cleaning. Return the used coupons to the Agency personnel with the coupon report. Any new coupon racks shall include a flow rate indicator, and/or a calibrated flow restrictor designed to maintain a flow rate not to exceed 3 feet per second and a 12-inch long horizontally oriented steel pipe spool piece.

2.07 SOLUTION TANKS

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc Water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Stationary OSHA approved 50-gallon capacity, polyethylene, self-supporting, 5-gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.
- C. Double wall spill containment tanks with MSDS sheets physically attached, corrosion resistant with at least 120% times the holding capacity of chemical solution tanks, one for each chemical.
- D. Contractor shall insure that delivery personal have proper safety equipment when completing chemical transfers. Any transfer containers used during this process shall be removed from the site once the transfer has been completed. If any empty chemical containers from the Contractor are on site during this delivery, they will also be removed.

2.08 AGITATOR

- A. Manufacturers:
 - 1. MIOX
 - 2. Ingersoll Rand
 - 3. Water Treatment by Design (WTBD)
 - 4. Arc Water Treatment
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Low RPM, totally enclosed electric motor, stainless steel clamp and motor mount, 4-inch diameter coated Type 316 stainless steel propeller.
- C. Electrical Characteristics:
 - 1. 120 volts, single phase, 60 Hz.
 - 2. Cord and Plug: Furnish unit with 12-foot cord and plug for connection to electric wiring system including grounding connector.



2.09 LIQUID LEVEL SWITCH

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc Water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low-level alarm.

2.10 CONDUCTIVITY CONTROLLER

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc Water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid
 - 6. Or equal as approved by the Professional.
- B. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit.
- C. Chemical feed equipment shall be able to provide the following equipment with these capabilities:
 - 1. Remote automation and control of existing Condenser Water system via Ethernet and or phone line.
 - 2. Capability to present live data 24/7 and alarming capabilities.
 - 3. Capability to control inhibitor feed using a fluorescent dye technology monitoring live ppm of product 24/7 at all times must be an option for both Boiler and Cooling Water feed systems.
 - 4. Automatic Boiler Surface Blowdown Controllers are required with motorized ball valves, plumbing sensors, and orifice unions for each steam boiler. All controllers must have the above capabilities.

2.11 WATER METER

- A. Manufacturers:
 - 1. MIOX
 - 2. Water Treatment by Design (WTBD)
 - 3. Arc Water Treatment
 - 4. Barclay Water Management
 - 5. Klenzoid



6. Or equal as approved by the Professional.

- B. Displacement type cold-water meter with sealed, tamper-proof magnetic drive, impulse contact register.

2.12 SOLENOID VALVES

- A. Manufacturers:

1. MIOX
2. Water Treatment by Design (WTBD)
3. Arc Water Treatment
4. Barclay Water Management
5. Klenzoid
6. Or equal as approved by the Professional.

- B. Forged brass body globe pattern, normally open or closed as required, general-purpose solenoid enclosure, and continuous duty coil.

- C. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.

2.13 TEST EQUIPMENT

- A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.

- B. Furnish following test kits:

1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulfite titration test kit.
4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 micro-ohms.
7. Creosol red pH slide, complete with reagent.
8. Portable electronic conductivity meter capable of measuring ORP and pH.
9. High nitrite test kit.
10. Digital colorimeter

2.14 WATER FILTRATION SAND

- A. Manufacturers:

1. AmeriWater.
2. Nalco (UltraSand series.)
3. Or equal as approved by the Professional.

- B. System Data

1. General



- a. Location: Shippensburg, PA
2. Condenser Water Performance
 - a. Design condenser water circulation flow: 9,000 gpm
 - b. Design temperature differential across towers: 10 deg F
 - c. Cycles of concentration: 3
 - d. Cooling tower
 - 1) three cells
 - 2) approx. 844,000 cfm total
3. Chilled Water Performance
 - a. Design chilled water volume: 2 million gal

C. Sand Filtration System

1. Sand filtration system shall be rated for:
 - a. Condenser water: 0.5 micron particle removal.
 - b. Chilled water: 0.25 micron particle removal.
2. Filter shall be comprised of #304 Stainless Steel tank(s) ASME labeled with a Type L copper manifold, copper control tubing, stainless steel skid and circulating pump.
3. Filter shall operate continuously removing suspended particles from water until either a set pressure drop across the filter bed is reached or twenty four hours has elapsed. At either point filter shall automatically backwash for 10 minutes on each vessel sequentially for condenser water and 5 minutes for chilled water. After backwash cycle, filter shall automatically return to original filtration mode.
4. The selection and sizing of the filtration system shall be based on and account for the condenser water (CW) system tonnage, the CW system design circulation rate, the CW design temperature drop across the tower and the cycles of concentration. The selection and sizing of the filtration system shall be based on and account for the chilled water (CHW) system design circulation rate. Filter system sizing shall also consider the local air quality, cooling tower air flow rates in CFM and the local water chemistry.
5. Provide Particle Distribution Analysis and calculations from three previous users where the criteria described in this spec were met. Include tower tonnage, tower water circulation rate, temperature drop across the tower, filter sand size and filtration rate. Note % of tower water circulation rate being filtered in each case. Include facility name, address, contacts and phone numbers. Analysis shall be on independent third party laboratory letter head.
6. Filter shall be designed to provide
 - a. Condenser water: 0.5 micron filtration by utilizing ultrafine sand with an effective size of not more than 0.16 millimeters.
 - b. Chilled water: 0.25 micron filtration by utilizing ultrafine sand with an effective size of not more than 0.10 millimeters.
7. Filter design flow rate shall be greater than 20 gpm per square foot of surface area.



8. Filter shall be sized to remove 50% by count or more of the 0.5 micron particles and 80% by count or more of the 2 microns particles typically found in the circulating cooling water, within 30 days of startup.
9. Natural quartz media shall meet AWWA B-100, ANSI, and NSF-61 standards for consistently uniform and chemically inert filter media. Crushed or ground media is not acceptable.
10. Filter system shall be rated for:
 - a. Condenser water: 70 psig inlet pressure to filter pump.
 - b. Chilled water: 70 psig inlet pressure to filter pump.
11. Tanks shall be #304 Stainless Steel rated for 300 psig operating pressure for chilled water and 200 psig operating pressure for condenser water and fabricated and labeled ASME.
12. Manifold shall be Type L copper.
13. Lower distributor will be of "V Notch" design which dislodges sand particles during backwash. Drilled hole design not acceptable.
14. Components:
 - a. Media shall be natural Quartz multimedia that is certified as to quality by NSF-61 standards. Crushed or ground media is not acceptable.
 - b. Valves shall be Johnson Controls two-piece brass ball type with EPDM stem seals, blowout proof stem design, stainless steel ball and stem, PTFE seats. Valves shall be actuated with individual 24V electric motors on each valve. The drain valve(s) shall be spring return normally closed.
 - c. Filter shall be equipped with two pressure gauges. The gauges shall have a stainless steel casing, with brass internals and be liquid filled. The minimum face size shall be no less than 2-1/2". One gauge marked (IN) shall be connected to the filter discharge and the second gauge marked (OUT) shall be connected to the outlet side of the filter. Both gauges shall be mounted to a support panel that shall be mounted above the filter control.
 - d. Backwash flow control shall be rated for full backwash flow with backwash water from 25 PSIG to 80 PSIG. The filter system shall use for backwash:
 - 1) Condenser water: condenser water.
 - 2) Chilled water: city water.
 - e. Filter pump
 - 1) Cast iron
 - 2) Close coupled with mechanical seal.
 - 3) Pump motor
 - a) 208V
 - b) Maximum motor HP: 5 for condenser water and 5 HP for chilled water
 - c) TEFC
 - d) Service factor of not less than 1.15.
 - f. Filter shall be mounted on a stainless steel skid



- g. PLC filter control shall be compatible with the existing BAS and shall have a NEMA 4X enclosure and shall contain the following:
 - 1) A 24 hour timer to force backwash once per day.
 - 2) A pressure differential switch which is factory set to initiate backwash at set pressure differential across the filter bed.
 - 3) A manual override switch, of a momentary contact design, mounted on the control box door.
 - 4) A program timer shall be designed to control the duration of the backwash cycle. It shall be engaged by either the 24 hour timer, pressure differential switch, or the manual override button.
 - 5) A light mounted on the outside of the panel door.
 - 6) A non-resettable backwash counter mounted on the outside of the panel door to indicate the number of times the filter has backwashed.
 - 7) A motor starter and disconnect.
 - 8) Step down transformers to convert 3 phase power to 115 volts AC to operate control components.
 - 9) Output contacts
 - a) Pump status
 - b) Backwash count
 - 10) Interlocks to disable sand filtration system
 - 11) The entire industrial control package shall be UL listed

PART 3 EXECUTION

3.01 PREPARATION

- A. Operate, fill, start and vent new piping systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.02 CLEANING

- A. Concentration: Liquid Alkaline Cleaner
 - 1. As recommended by manufacturer.
 - 2. One pound per 100 gallons of water contained in the system.
 - 3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
 - 4. Fill steam boilers only with cleaner and water.
- B. New Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.



- C. New Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
- D. New Steam Systems:
 - 1. Apply heat, slowly raising boiler temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Cool, then drain as quickly as possible.
 - 3. Refill with clean water, drain, refill and check for sludge.
 - 4. Repeat until system is free of sludge.
 - 5. Apply heat to produce steam for piping system and maintain for 8 hours minimum. Bypass traps and waste condensate.
- E. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of the Professional.
- F. Flush open systems with clean water for one hour minimum. Drain completely and refill.
- G. Remove, clean, and replace pump strainer screens.
- H. Remove, clean, and replace temporary system strainer screens.
- I. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- J. After cleaning process is completed and system free of sludge, replace temporary system strainers with spool pieces.

3.03 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each new system. Install isolating and drain valves and interconnecting piping. Install around balancing valve downstream of circulating pumps as indicated on Drawings.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Install 3/4 inch water coupon rack around circulating pumps with space for four test specimens.

3.04 STEAM SYSTEM TREATMENT

- A. Provide boiler feed tanks to each boiler along with a separate Sulfite feed to the deaerator tank. All chemical feed pumps will be electrically tied into the dedicated boiler feedwater pump for chemical feeds proportionally to feedwater makeup.



3.05 CONDENSER WATER SYSTEMS (COOLING TOWERS)

- A. Provide automatic condenser water control systems for inhibitor feed, blow-down, and two alternating biocide feeds.
 - 1. Provide meter activated inhibitor application.
 - 2. Provide conductivity activated blow-down.
 - 3. Provide meter fed biocide with blow-down locked out to ensure biocide retention time.
- B. Incorporate solid state integrated circuits and digital LED displays, in NEMA 250 Type 12 steel enclosure. Provide lockable door with gaskets.
- C. Base dissolved solids control on conductivity and include:
 - 1. LED digital readout display (micro-ohm/cm).
 - 2. Temperature compensated sensor probe adaptable to sample stream manifold.
 - 3. High, low, normal conductance indicator lights (LED).
 - 4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Furnish flash or steady switch with silence position.
 - 5. Illuminated legend indicating "ALARM" whenever alarm condition exists.
 - 6. Hand-off-automatic switch for solenoid bleed valve.
 - 7. Illuminated legend indicating "BLEED" when valve is operated.
 - 8. Adjustable hysteresis or dead-band (internal).
- D. Base inhibitor feed control on make-up volume and include:
 - 1. Solid state counter (1-15 field selectable).
 - 2. Solid state timer (adjustable 1/4 to 5 minutes).
 - 3. Test switch.
 - 4. Hand-off-automatic switch for chemical pump.
 - 5. Illuminated legend indicating "FEED" when pump is activated.
 - 6. Solid state lockout timer (adjustable 1/4 to 3 hours) and indicator light. Lockout timer to deactivate pump and activate alarm circuits.
 - 7. Panel total (quantity of makeup), Electro-mechanical type.
- E. Biocide programmer to include:
 - 1. 24-hour timers with 14 day skip feature.
 - 2. Precision solid state bleed lockout timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
 - 3. Solid state alternator to enable use of two different formulations.
 - 4. Digital display of time of day (24 hours).
 - 5. LED display of day of week (14 days).
 - 6. Fast and slow clock set controls (internal).
 - 7. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
 - 8. Hand-off-automatic switches for biocide pumps.
 - 9. Illuminated legend indicating "BIOCIDE A" or "BIOCIDE B" when pump is activated.



- F. Provide water meter on system make-up, wired to control system.
- G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator in accordance with treatment supplier's recommendations.
- H. Provide conductivity controller to sample condenser water and operate solenoid bleed valve and piping to blow-down controller. Wire sampler to open when condenser water pump is operating.
- I. Introduce biocide to tower by continuous feed with solution pump or solenoid valve on tank (chlorine).
- J. Provide liquid level switch in each solution tank to de-activate solution pump and agitator, and signal mechanical alarm system; refer to Section 23 09 00.
- K. Install 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.06 DEMONSTRATION

- A. Furnish eight hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems.

3.07 INSTALLATION

- A. Sand Filtration System
 - 1. Place vessels as shown in installation drawing and level. Use manifold as guide for spacing.
 - 2. Install upper and lower manifolds as per manufacturer's instructions.
 - 3. Install piping between manifold and pumps. Connect control tubing to valves and manifold according to manufacturer's instructions.
 - 4. Connect electrical power to control panel and control to pumps according to local electrical codes and wiring diagram supplied by manufacturer.
 - 5. Install media according to manufacturer's instructions.

3.08 STARTUP AND TESTING

- A. Sand Filtration System
 - 1. Startup by factory authorized agent shall be provided.
 - 2. Submit cooling water particle analysis reports showing frequency and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 5, 5 to 10, 10 to 15, 15 to 20, and 20 and larger at time of startup.
 - 3. Submit cooling water particle analysis reports showing frequency and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 5, 5 to 10, 10 to 15, 15 to 20, and 20 and larger 30 days after startup.



4. Submit report analyzing results from both particle analyses confirming that system meets performance specifications called out above.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	08/08/2018	RFI-0310	Added to B04	Updated for RFI-310.



SECTION 15410

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for plumbing fixtures and related components.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01732 - Cutting and Patching.
 - 3. Section 01810 – Commissioning.
 - 4. Section 07920 – Joint Sealants.
 - 5. Section 15050 – Basic Mechanical Materials and Methods.
 - 6. Section 15110 – Valves.
 - 7. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Definitions:
 - 1. Accessible Fixture: A plumbing fixture that can be approached, entered, and used by people with disabilities.
 - 2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 3. Fitting: A device that controls the flow of water into or out of a plumbing fixture.
 - a. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes.
 - b. Piping and general-duty valves are included where indicated in this Section.
 - 4. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.

- B. Reference Standards:



1. The International Association of Plumbing and Mechanical Officials (IAPMO)/American National Standards Institute (ANSI):
 - a. IAPMO/ANSI Z124.5 - Plastic Toilet (Water Closets) Seats.
2. American Society of Mechanical Engineers (ASME):
 - a. ASME A112.6.1M – Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - b. ASME A112.6.3 – Floor and Trench Drains.
 - c. ASME A112.18.1/CSA B125.1 – Plumbing Supply Fittings.
 - d. ASME A112.18.3 - Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings.
 - e. ASME A112.19.1/CSA B45.2 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures.
 - f. ASME A112.19.2/CSA B45.1 - Ceramic Plumbing Fixtures.
 - g. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 - h. ASME A112.19.4M –Porcelain Enameled Formed Steel Plumbing Fixtures.
 - i. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
 - j. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
 - k. ASME B1.20.7 - Hose Coupling Screw Threads, Inch.
3. American Society of Sanitary Engineers (ASSE):
 - a. ANSI/ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
 - b. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
 - c. ANSI/ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers.
 - d. ANSI/ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.
 - e. ANSI/ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations.
 - f. ASSE 1025 Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon Type, Residential Applications [*withdrawn 2006*].
 - g. ASSE 1037 Performance Requirements for Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures.
4. ASTM International (ASTM):
 - a. ASTM D 3901 - Standard Specification for Garden Hose [*withdrawn 1997*].



- b. ASTM F 409 - Standard Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings.
 - c. ASTM F 444 Standard Consumer Safety Specification for Scald-Preventing Devices and Systems in Bathing Areas.
 - d. ASTM F 445. Standard Consumer safety Specification for Thermal-Shock-Preventing Devices and Systems in Showering Areas.
- 5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. ICC/A117.1 - Accessible and Usable Buildings and Facilities.
- 7. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
- 8. NSF International (NSF):
 - a. NSF/ANSI 2 - Food Equipment.
 - b. NSF/ANSI 61 - Drinking Water System Components - Health Effects.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. UL 486A-486B - Wire Connectors.
 - b. UL 1951 - Standard for Safety Electric Plumbing Accessories.
- 10. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - b. United States Code (U.S.C.):
 - 1) 42 U.S.C. Section 4151 et seq.
 - a) Architectural Barriers Act, Public Law 90-480.
 - 2) 42 U.S.C. Section 12101 et seq.
 - a) Americans with Disabilities Act (ADA), Public Law 101-336.
 - 3) 42 U.S.C. Section 13201 et seq.
 - a) Energy Policy Act, Public Law 102-486.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the roughing-in and final plumbing fixture locations, and verify that the fixtures can be installed in accordance with the original design and referenced standards.

1.04 SUBMITTALS

A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Product Data:
 - 1) Lavatory faucets.
 - 2) Toilet seats.
 - 3) Fixture supports.
 - 4) Water closets.
 - 5) Urinals.
 - 6) Lavatories.
 - 7) Sinks.
 - 8) Thermostatic Control Valves (at Lavatories)
- b. Shop Drawings:
 - 1) Power wiring.
 - 2) Signal wiring.
 - 3) Control wiring.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal

Procedures:

- a. Manufacturer's Instructions:
 - 1) Plumbing fixture manufacturers' written installation instructions.

1.05 QUALITY ASSURANCE

A. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled for the location the product is installed in, and the application intended, by a Nationally Recognized Testing Laboratory (NRTL), as defined in Article 100 of NFPA 70, acceptable to the Authorities Having Jurisdiction (AHJ), unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.



- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver all materials in the manufacturer's original packaging.
 - 2. Thoroughly inspect the materials upon receipt, and report damaged material to the delivering carrier.
- B. Storage and Handling Requirements:
 - 1. Store materials in dry, protected, well-vented area.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain plumbing fixtures, faucets, and other components in each category from a single manufacturer and through one source.
 - a) If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Description:
 - 1. Regulatory Requirements:



- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. NSF International (NSF) Compliance:
 - 1) For plumbing fixture materials that will be in contact with potable water, comply with the requirements specified in NSF/ANSI 61.
 - c. Accessibility Laws and Regulations:
 - 1) Comply with the applicable accessibility laws and regulations for plumbing fixtures for people with disabilities, including, but not limited to, the following:
 - a) ICC/A117.1.
 - b) Architectural Barriers Act, Public Law 90-480.
 - c) Americans with Disabilities Act (ADA), Public Law 101-336.
 - d. Conservation Regulations:
 - 1) Comply with the applicable conservation laws and regulations for water flow and consumption rates for plumbing fixtures, including, but not limited to, the following:
 - a) Energy Policy Act, Public Law 102-486.
- C. Design Criteria:
- 1. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - 2. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
 - 3. Plumbing Fixtures:
 - a. Provide plumbing fixtures complying with the following applicable standards and other requirements specified:
 - 1) Enameled, Cast-Iron Fixtures:
 - a) Provide enameled, cast-iron fixtures complying with the requirements specified in ASME A112.19.2/CSA B45.1.
 - 2) Hand Sinks:
 - a) Provide hand sinks complying with the construction requirements specified in NSF/ANSI 2.
 - 3) Porcelain-Enameled, Formed-Steel Fixtures:
 - a) Provide porcelain-enameled, formed-steel fixtures complying with the requirements specified in ASME A112.19.4M.
 - 4) Stainless-Steel Fixtures Other Than Service Sinks:
 - a) Provide stainless-steel fixtures other than service sinks complying with the requirements specified in ASME A112.19.3.



- 5) Vitreous-China Fixtures:
 - a) Provide vitreous-china fixtures complying with the requirements specified in ASME A112.19.2/CSA B45.1.
- 6) Water-Closet, Flush Valve, Tank Trim:
 - a) Provide water-closet, flush valve, tank trim complying with the requirements specified in ASME A112.19.5.
- 7) Water-Closet, Flushometer Tank Trim:
 - a) Provide water-closet, flushometer tank trim complying with the requirements specified in ASSE 1037.
4. Lavatory and Sink Faucets:
 - a. For lavatory and sink faucets, comply with the requirements specified in the following standards as applicable to the item and other requirements specified:
 - 1) Backflow Protection Devices:
 - a) For faucets having side spray and for faucets having hose-thread outlets, provide backflow protection devices complying with the requirements specified in ASME A112.18.3.
 - 2) Diverter Valves:
 - a) For faucets having hose spray, provide diverter valves complying with the requirements specified in ASSE 1025.
 - 3) Faucet Hoses:
 - a) Provide faucet hoses complying with the requirements specified in ASTM D 3901.
 - 4) Faucets:
 - a) Provide faucets complying with the requirements specified in ASME A112.18.1/CSA B125.1.
 - 5) Hose-Connection Vacuum Breakers:
 - a) Provide hose-connection vacuum breakers complying with the requirements specified in ANSI/ASSE 1011.
 - 6) Hose-Coupling Threads:
 - a) Provide hose-coupling having threads complying with the requirements specified in ASME B1.20.7
 - 7) Vacuum Breakers:
 - a) Provide integral, atmospheric vacuum breakers complying with the requirements specified in ANSI/ASSE 1001.
 - 8) NSF International Materials (previously the National Sanitation Foundation):
 - a) Provide materials that will come into contact potable water complying with the requirements specified in NSF/ANSI 61.
 - 9) Pipe Threads:



- a) Provide pipe threads complying with the requirements specified in ASME B1.20.1.
- 10) Sensor-Actuated Faucets and Electrical Devices:
 - a) Provide sensor-actuated faucets and electrical devices complying with the requirements specified in UL 1951.
- 11) Supply and Drain Fittings:
 - a) Provide supply and drain fittings complying with the requirements specified in ASME A112.18.1/CSA B125.1.
- 5. Shower Faucets:
 - a. For shower faucets, comply with the requirements specified in the following standards as applicable to the item and other requirements specified:
 - 1) Backflow Protection Devices for Hand-Held Showers:
 - a) Provide backflow protection devices for hand-held showers complying with the requirements specified in ASME A112.18.3.
 - 2) Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets:
 - a) Provide combination, pressure-equalizing and thermostatic-control antiscald faucets complying with the requirements specified in ANSI/ASSE 1016.
 - 3) Faucets:
 - a) Provide faucets complying with the requirements specified in ASME A112.18.1/CSA B125.1.
 - 4) Hand-Held Showers:
 - a) Provide hand-held showers complying with the requirements specified in ANSI/ASSE 1014.
 - 5) High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices:
 - a) For thermal-shock-preventing devices, provide high-temperature-limit controls complying with the requirements specified in ASTM F 445.
 - 6) Hose-Coupling Threads:
 - a) Provide hose-couplings having threads complying with the requirements specified in ASME B1.20.7.
 - 7) Manual-Control Antiscald Faucets:
 - a) Provide manual-control antiscald faucets complying with the requirements specified in ASTM F 444.
 - 8) Pipe Threads:
 - a) Provide pipes threads complying with the requirements specified in ASME B1.20.1.



- 9) Pressure-Equalizing-Control Antiscald Faucets:
 - a) Provide pressure-equalizing-control antiscald faucets complying with the requirements specified in ASTM F 444 and ANSI/ASSE 1016.
- 10) Thermostatic-Control Antiscald Faucets:
 - a) Provide thermostatic-control antiscald faucets complying with the requirements specified in ASTM F 444 and ANSI/ASSE 1016.
6. Miscellaneous Fittings:
 - a. For miscellaneous fittings, comply with the requirements specified in the following standards as applicable to the item and other requirements specified:
 - 1) Atmospheric Vacuum Breakers:
 - a) Provide atmospheric vacuum breakers complying with the requirements specified in ANSI/ASSE 1001.
 - 2) Brass and Copper Supplies:
 - a) Provide Brass and Copper Supplies complying with the requirements specified in ASME A112.18.1/CSA B125.1.
 - 3) Manual-Operation Flushometers:
 - a) Provide manual-operation flushometers complying with the requirements specified in ASSE 1037.
 - 4) Plastic Tubular Fittings and Piping:
 - a) Provide plastic tubular fittings and piping complying with the requirements specified in ASTM F 409.
 - 5) Sensor-Operation Flushometers:
 - a) Provide sensor-operated flushometers complying with the requirements specified in ASSE 1037 and UL 1951.
 - 6) Tubular Brass Drainage Fittings and Piping:
 - a) Provide tubular brass drainage fittings and piping complying with the requirements specified in ASME A112.18.1/CSA B125.1.
7. Miscellaneous Components:
 - a. For miscellaneous components, comply with the requirements specified in the following standards as applicable to the item and other requirements specified:
 - 1) Floor Drains:
 - a) Provide floor drains complying with the requirements specified in ASME A112.6.3.
 - 2) Hose-Coupling Threads:
 - a) Provide hose-coupling threads complying with the requirements specified in ASME B1.20.7.



- 3) Off-Floor Fixture Supports:
 - a) Provide off-floor fixture supports complying with the requirements specified in ASME A112.6.1M.
- 4) Pipe Threads:
 - a) Provide pipe threads complying with the requirements specified in ASME B1.20.1.
- 5) Plastic Toilet Seats:
 - a) Provide plastic toilet seats complying with the requirements specified in IAPMO/ANSI Z124.5.
- 6) Supply and Drain Protective Shielding Guards:
 - a) Provide supply and drain protective shielding guards complying with the requirements specified in ICC A117.1.
8. Product Data:
 - a. Obtain the manufacturer's Product Data for the following products proposed for the Work of this Section:
 - 1) Lavatory faucets.
 - 2) Toilet Seats.
 - 3) Fixture Supports.
 - 4) Water Closets.
 - 5) Urinals.
 - 6) Lavatories.
 - 7) Sinks.
 - b. Submit the Product Data to the Program/Project Manager for approval.
9. Shop Drawings:
 - a. Prepare wiring diagrams for the following wiring, differentiating between manufacturer-installed and field-installed wiring:
 - 1) Power wiring.
 - 2) Signal wiring.
 - 3) Control wiring.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.

D. Materials:

1. Lavatory Faucets:
 - a. Provide lavatory faucets that include hot-water and cold-water indicators.
 - b. Coordinate the faucet inlets with the supplies and fixture holes and the faucet outlet with the spout and fixture receptor.
 - c. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - d. Manufacturers:



- 1) American Standard, www.americanstandard-us.com.
 - 2) Grohe America, <https://www.faucetdirect.com/grohe>.
 - 3) Sloan, www.sloanvalve.com.
 - 4) Symmons, www.symmons.com.
 - 5) Approved equal.
2. Sink Faucet:
 - a. Provide sink faucets that include hot- and cold-water indicators.
 - b. Coordinate the faucet inlets with the supplies and fixture holes and the faucet outlet with the spout and fixture receptor.
 - c. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - d. Manufacturers:
 - 1) Chicago Faucet Co., www.chicagofaucets.com
 - 2) Elkay Manufacturing Co., www.elkay.com
 - 3) Geberit Manufacturing Inc., www.us.geberit.com
 - 4) Sloan, www.sloanvalve.com
 - 5) Approved equal.
3. Flushometers:
 - a. Provide flushometers having a cast-brass body with corrosion-resistant internal components, a control stop with a check valve, a vacuum breaker, and copper or brass tubing.
 - b. On exposed parts, provide a polished chrome-plated finish.
 - c. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - d. Manufacturers:
 - 1) Sloan, www.sloanvalve.com
 - 2) Zurn, www.zurn.com.
 - 3) Approved equal.
4. Toilet Seats:
 - a. Provide solid plastic toilet seats.
 - b. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - c. Manufacturers:
 - 1) Bemis, www.bemisseats.com.
 - 2) Centoco, www.centoco.com.
 - 3) Church, www.churchseats.com.
 - 4) Approved equal.
5. Protective Shielding Guards:
 - a. Provide manufactured, plastic coverings for hot-water supply, and trap and drain, piping complying with requirements specified in the Americans with Disabilities Act (ADA).



- b. Manufacturers:
 - 1) Delta Faucet Company, Scald-Gard, <http://www.deltafaucet.com>.
 - 2) Truebro, www.trubro.com.
 - 3) Approved equal.
- 6. Fixture Supports:
 - a. Urinal Supports:
 - 1) Provide Type I urinal carriers having fixture support plates and a coupling with seal and fixture bolts and hardware matching the fixture.
 - a) Include steel uprights with feet.
 - b. Lavatory Supports:
 - 1) Provide Type II, lavatory carriers having concealed arms and tie rods.
 - a) Include steel uprights with feet.
 - 2) Manufacturers:
 - a) Jay R. Smith, Mfg. Co., www.jrsmith.com.
 - b) Approved equal.
 - c. Accessible Fixture Supports:
 - 1) Provide accessible fixture supports that include rectangular steel uprights
- 7. Water Closets:
 - a. Provide accessible floor-mounting and standard height floor-mounting, floor-outlet, vitreous-china water closet fixtures designed for gravity-type tank operation.
 - b. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - c. Manufacturers:
 - 1) American Standard. www.americanstandard-us.com.
 - 2) Eljer, www.eljer.com.
 - 3) Approved equal.
- 8. Urinals:
 - a. Provide accessible wall-hanging, back-outlet, vitreous-china urinal fixtures designed for flushometer valve operation.
 - b. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - c. Manufacturers:
 - 1) American Standard. www.americanstandard-us.com.
 - 2) Eljer, www.eljer.com.
 - 3) Approved equal.
- 9. Lavatories:



- a. Provide accessible, self-rimming, counter-mounting vitreous-china lavatory fixtures
 - b. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - c. Manufacturers:
 - 1) American Standard. www.americanstandard-us.com.
 - 2) Eljer, www.eljer.com.
 - 3) Approved equal.
10. Sinks:
- a. Where "S-1" is indicated on the Contract Drawings, provide self-rimming, vitreous china hand wash sinks.
 - b. Provide the models, capacities, and other characteristics as indicated in the Plumbing Fixture Schedule on the Contract Drawings.
 - c. Manufacturers:
 - 1) American Standard. www.americanstandard-us.com.
 - 2) Elkay Manufacturing Co., www.elkay.com.
 - 3) Eljer, www.eljer.com.
 - 4) Approved equal.

2.02 ACCESSORIES

- A. Valves:
 - 1. For general-duty valves, provide valves complying with the requirements specified in Section 15110, Valves.
- B. Escutcheons:
 - 1. Provide escutcheons complying with the requirements for escutcheons specified in Section 15050, Basic Mechanical Materials and Methods.
- C. Grouts:
 - 1. Provide grout complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.
- D. Sealants:
 - 1. Provide sealant and sealant installation complying with the requirements specified in Section 07920, Joint Sealants.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:



1. Before installing plumbing fixtures, examine the roughing-in Work for water and for waste piping systems and supports to verify the actual locations and sizes of the piping connections, and to verify that the locations and types of supports match those indicated on the Contract Drawings.
 - a. If roughing-in data are not indicated on the Contract Drawings, use the manufacturer's roughing-in data.
 2. Examine walls, floors, and cabinets where fixtures are to be installed for suitable conditions.
- B. Evaluation and Assessment:
1. Proceed to install the plumbing fixtures only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect adjacent areas from damage resulting from installation of the plumbing fixtures.
- B. Demolition/Removal:
1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Assemble the plumbing fixtures, trim, fittings, and other components in accordance with the requirements specified in the plumbing fixture manufacturers' installation instructions.
1. Install fixtures level and plumb in accordance with the manufacturers' instructions and roughing-in drawings.
 2. Submit the plumbing fixture manufacturers' written installation instructions to the Program/Project Manager for information.
- B. Wall-Hanging Fixtures:
1. For wall-hanging fixtures, install off-floor supports affixed to the building substrate
 - a. For back-outlet fixtures, provide carrier supports having a waste fitting and seal.
 - b. For fixtures with tubular waste piping, provide carrier supports without waste fittings.
 - c. For accessible fixtures, provide chair-type carrier supports having rectangular steel uprights.



2. Install back-outlet, wall-hanging fixtures onto waste fitting seals, and attach them to the supports.
 3. Install wall-hanging fixtures having tubular waste piping attached to the supports.
- C. Floor-Mounted Fixtures:
1. Install floor-mounting fixtures on closet flanges or other attachments to the piping or building substrate.
- D. Counter-Mounted Fixtures:
1. Install counter-mounting fixtures in and attached to the casework.
- E. Piping:
1. Piping installation requirements are specified in other Sections.
 2. Supply and Waste Connections to Plumbing Fixtures
 - a. To connect fixtures, provide water supplies, stops, risers, traps, and waste piping.
 - b. Provide the size of fittings required to match the fixtures.
 - c. Connect fixtures to the plumbing piping..
 3. Water-Supply Piping:
 - a. Install water-supply piping with a stop on each supply to each fixture to be connected to water distribution piping.
 - b. Attach the supplies to supports or the substrate within pipe spaces behind the fixtures.
 - c. Install stops in locations where they can be easily reached for operation.
 - 1) If stops are not specified with the fixture, provide a ball, gate, or globe valve in lieu of the stops.
 4. Waste Piping:
 - a. Install trap and tubular waste piping on the drain outlet of each fixture to be directly connected to sanitary drainage system.
 - b. Install tubular waste piping on the drain outlet of each fixture to be indirectly connected to the drainage system.
- F. Valves and Fittings:
1. For accessible water closets and urinals, install flushometer valves with the handle mounted on the wide side of the compartment.
 - a. Install other actuators in locations that are easy for people with disabilities to reach.
 2. If faucets are not available with the required rates and patterns, install faucet-spout fittings having the specified flow rates and patterns in the faucet spouts, and include adapters if required.



3. Install water-supply, flow-control fittings with specified flow rates in the fixture supplies at the stop valves.
4. If faucets are not available with the required rates and patterns, install faucet, flow-control fittings having the specified flow rates and patterns in the faucet spouts, and include adapters if required.
5. Install shower, flow-control fittings having the specified maximum flow rates in shower arms.
6. Except for fixtures with integral traps and on indirect wastes, install traps on the fixture outlets, unless otherwise indicated in the Contract Documents.

G. Disposers:

1. Provide a disposer in the outlet of sinks indicated to have a disposer
2. Install the switch for the disposer where indicated in the Contract Documents, or if a location is not indicated in the Contract Documents install the switch for the disposer in the wall adjacent to the sink.

H. Escutcheons:

1. At piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork, install escutcheons.
2. If required to conceal protruding fittings, provide deep-pattern escutcheons.

I. Basins:

1. Set basins in a leveling bed of cement grout.

J. Joints between Fixtures and Walls, Floors, and Counters:

1. Seal the joints between fixtures and walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant.
2. Match the sealant color to the fixture color.

K. Toilet Seats:

1. Install toilet seats on water closets

L. Special Techniques:

1. Grounding Equipment:
 - a. Ground equipment.
 - b. Tighten electrical connectors and terminals according to the manufacturer's published torque-tightening values.
 - 1) If the manufacturer's torque values are not indicated in the manufacturer's published material, use the torque values specified in UL 486A-UL 486B.



M. Systems Integration:

1. Connect water supplies from the water distribution piping to the fixtures.
2. Connect drain piping from the fixtures to the drainage piping.
3. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections:
 - a. To connect fixtures and equipment, provide the water supplies, stops, risers, traps, and waste piping specified.
 - b. Provide the size of fittings required to match the fixtures and equipment.
 - c. Connect fixtures and equipment to the plumbing piping.

3.04 REPAIR/RESTORATION

- A. Replace the washers and seals of leaking and dripping faucets and stops.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Operational Test:
 - a. Test Procedure:
 - 1) After the water systems are pressurized, test the installed fixtures for proper operation.
 - 2) Replace malfunctioning fixtures and components, then retest the replacements.
 - b. Acceptance Criteria:
 - 1) Repeat procedure until units operate properly.
2. Inspections:
 - a. Inspect installed fixtures for damage.
 - b. Verify that the fixtures installed are of the categories and types specified for the locations where they are installed.
 - c. Check that the fixtures are complete with trim, faucets, fittings, and other specified components.

B. Non-Conforming Work

1. Replace damaged fixtures and components with undamaged fixtures and components at no increase in the Contract Price.

3.06 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork,



air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

- A. Install fresh batteries in sensor-operated mechanisms that require batteries.

3.07 ADJUSTING

- A. Operate and adjust the faucets and controls.
 - 1. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers and controls.
 - 1. Replace damaged and malfunctioning units and controls.
- C. Adjust the water pressure at faucets, shower valves, and flushometer valves to produce the proper flow and stream.

3.08 CLEANING

- A. Clean fixtures, faucets, and other fittings using the manufacturers' recommended cleaning methods and materials.
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and then reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.09 PROTECTION

- A. Provide protective coverings for installed fixtures and fittings.
- B. Do not allow the fixtures to be used as temporary facilities unless prior approval in writing is obtained from the Program/Project Manager.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for the plumbing fixtures for inclusion in Operation and Maintenance manuals as specified in Section 01780, Closeout Submittals.



2. Submit the operation and maintenance data for the plumbing fixtures to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15425

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for water coolers and related components, including the following:
 - a. Pressure water coolers.
 - b. Fixture supports.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 07920 – Joint Sealants.
 - 6. Section 15050 – Basic Mechanical Materials and Methods.
 - 7. Section 15060 – Hangers and Supports.
 - 8. Section 15110 – Valves.
 - 9. Section 15140 – Domestic Water Piping.
 - 10. Section 15150 – Sanitary Waste and Vent Piping.
 - 11. Section 16061 – Electrical Grounding and Bonding.
 - 12. Section 16120 – Conductors and Cables.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. EPA: United States Environmental Protection Agency (EPA).
 - 3. NPS: Nominal Pipe Size.
 - a. DN: Diamètre nominal (European Equivalent).
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Accessible Water Cooler: A fixture that can be approached and used by people with disabilities.
 - 3. Drinking Fountain: A fixture having a nozzle for delivering a stream of water for drinking.
 - 4. Fitting: A device that controls the flow of water into or out of a plumbing fixture.



5. Fixture: A drinking fountain or water cooler, unless another one is specifically indicated.
6. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
7. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

C. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME A112.6.1M – Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - b. ANSI/ASME A112.18.2/CSA B125.2 – Plumbing Waste Fittings.
 - c. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - d. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
2. American Society of Heating, Refrigerating and Air- Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE Standard 18 – Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration.
 - b. ASHRAE Standard 34 – Designation and Safety Classification of Refrigerants.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - b. ICC/A117.1 - Accessible and Usable Buildings and Facilities.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
6. NSF International (NSF):
 - a. NSF/ANSI 42 - Drinking Water Treatment Units - Aesthetic Effects.
 - b. NSF/ANSI 53 - Drinking Water Treatment Units - Health Effects.
 - c. NSF/ANSI 61 - Drinking Water System Components - Health Effects.
7. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 141 National Primary Drinking Water Regulations.
 - b. United States Code (U.S.C.):
 - 1) 42 U.S.C. Section 300f et seq.
 - a) Safe Drinking Water Act, Public Law 104-182.
 - 2) 42 U.S.C. Section 4151 et seq.
 - a) Architectural Barriers Act, Public Law 90-480.
 - 3) 42 U.S.C. Section 12101 et seq.
 - a) Americans with Disabilities Act (ADA), Public Law 101-336.



1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Pressure water coolers.
 - 2) Fixture supports.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) Power, signal, and control wiring diagrams.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Drinking fountain and water cooler manufacturer's written handling instructions.
 - 2) Drinking fountain and water cooler manufacturer's written cleaning instructions.
 - b. Site Quality Control Submittals:
 - 1) Water Cooler Test results.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the drinking fountains and water coolers.
- D. Maintenance Material Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Furnish extra stock materials that match the products installed in the following quantities, and package the extra stock materials with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Filter Cartridges:
 - (1) For each type and size of filter cartridge installed, furnish spare filter cartridges equal to 10 percent of the filter cartridge installed, but not less than one of each type and size.

1.05 QUALITY ASSURANCE

A. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver all materials in the manufacturer's original packaging.
 - a. Clean flanges and exposed machined metal surfaces, and treat them with an anticorrosion compound after assembly and testing.
 - b. Protect flanges and pipe openings with wooden flange covers or with screwed-in plugs.



2. Thoroughly inspect the materials upon receipt, and report damaged material to the delivering carrier.
- B. Storage and Handling Requirements:
 1. During storage, retain protective covers on flanges and protective coatings.
 2. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
 3. Comply with the drinking fountain and water cooler manufacturer's handling instructions.
 - a. Submit the drinking fountain and water cooler manufacturer's written handling instructions to the Program/Project Manager for information.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 DRINKING FOUNTAIN AND WATER COOLER EQUIPMENT

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. Accessibility Regulations:
 - 1) For drinking fountain and water cooler fixtures for people with disabilities, provide accessible water coolers complying with the regulations and requirements specified in ICC/A117.1, Public Law 90-480, and Public Law 101-336.
 - 2) For drinking fountain and water cooler fixtures intended for children, install the fixtures at the height required by the Authorities Having Jurisdiction.



- c. Health and Sanitary Regulations:
 - 1) For the drinking fountain and water cooler fixture materials that will be in contact with potable water, comply with the requirements specified in NSF/ANSI 61.
 - 2) Refrigerants:
 - a) Provide refrigerants complying with the requirements for water cooler refrigerants specified in ASHRAE 34.
 - (1) Unless otherwise indicated in the Contract Documents, provide HFC 134a (tetrafluoromethane) refrigerant.
 - 3) Cyst and Lead Filtration:
 - a) Comply with the requirements specified in NSF 42 and NSF 53 for cyst and lead reduction to below United States Environmental Protection Agency (EPA) standards codified in the Safe Drinking Water Act and 40 CFR 141.
- C. Performance:
 - 1. Capacity:
 - a. Provide a cooling system capable of supplying 8 gallons per hour (0.0084L/s) of cooled water at 50 degrees Fahrenheit (10 degrees Celsius) when supplied with 80 degrees Fahrenheit (27 degrees Celsius) inlet water in an ambient air temperature of 110 degrees Fahrenheit (32 degrees Celsius).
- D. Design Criteria:
 - 1. Provide drinking fountains and water coolers complying with the requirements for the type and style classifications provided as specified in ANSI/ASHRAE Standard 18.
 - 2. The Contract Drawings indicate the general arrangement of the drinking fountain and water cooler piping, fittings, and specialties.
 - 3. Supports:
 - a. For wall-mounting drinking fountain and water cooler fixtures, provide carrier off-floor supports unless otherwise indicated in the Contract Documents.
 - b. For recessed water coolers, provide mounting frames unless otherwise indicated in the Contract Documents.
 - c. For freestanding and pedestal drinking fountains, set the drinking fountains on the floor.
 - d. For remote water coolers, set the water coolers on floor unless otherwise indicated in the Contract Documents.
 - 4. Product Data:
 - a. Obtain the manufacturer's Product Data for each drinking fountain and water cooler fixture indicated to be provided in the Contract Documents.
 - 1) Ensure that the specific fixtures and their rated capacities, furnished specialties, and accessories are clearly indicated in the Product Data.



- 2) Indicate the type of refrigerant being provided.
 - b. Submit the Product Data for each drinking fountain and water cooler fixture to the Program/Project Manager for approval.
5. Shop Drawings:
 - 1) Prepare Shop Drawings that diagram the power, signal, and control wiring for drinking fountains and water coolers.
 - 2) Submit the Shop Drawings for the drinking fountains and water coolers to the Program/Project Manager for approval.

E. Materials:

1. Pressure Water Coolers:
 - a. Provide accessible water coolers complying with the requirements for Type PB, pressure with bubbler, and Style RE, recessed water cooler, water coolers specified in ARI 1010, and having a bi-level for adult and child-mounting heights.
 - 1) Cabinet:
 - a) Provide all stainless steel water cooler cabinets.
 - 2) Bubbler:
 - a) Provide 1 bubbler located on the deck of each water cooler unit.
 - b) Provide bubblers having an adjustable stream regulator.
 - 3) Control:
 - a) Provide a push bar control for operating the water cooler.
 - 4) Supply:
 - a) Provide 3/8-inch nominal pipe size [NPS 3/8 (DN 10)] supply connections having a ball, gate, or globe valve.
 - b) For locations exposed to view, provide chrome-plated brass or copper tubes, fittings, and valves.
 - c) For concealed locations, provide plain copper tubes, fittings, and valves.
 - 5) Filter:
 - a) Provide 1 or more water filters complying with the requirements specified in NSF 42 and NSF 53 for cyst and lead reduction to below United States Environmental Protection Agency (EPA) standards, and having a capacity sized for the unit peak flow rate.
 - 6) Drain:
 - a) For each water cooler unit, provide 1 grid drain having at least a 1-1/4-inch nominal pipe size [NPS 1-1/4 (DN 32)] horizontal waste line, and a trap complying with the requirements specified in ANSI/ASME A112.18.2/CSA B125.2.
 - 7) Cooling System:
 - a) Provide an electric cooling system consisting of a hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and an adjustable thermostat.



- b) Power Supply:
 - (1) Provide a 120-Volts AC, single phase, 60 Hertz cooling system power supply designed to deliver 1/5 horsepower.
 - 8) Ventilation Grilles:
 - a) Provide a stainless steel ventilation grille located below the fountain on each water cooler.
 - 9) Supports:
 - a) Provide a mounting frame for attaching the water cooler to the substrate.
 - b. Manufacturers:
 - 1) Elkay Manufacturing Co., <http://www.elkay.com>.
 - 2) Halsey Taylor, <http://www.halseytaylor.com>.
 - 3) Haws Corporation, <http://www.hawesco.com>.
 - 4) Oasis Corporation, a Division of Sunroc Corporation, <http://www.oasiscoolers.com>.
 - 5) Approved equal.
- 2. Fixture Supports:
 - a. Provide water cooler carriers complying with the requirements specified in ANSI/ASME A112.6.1M; and including vertical steel uprights having feet and tie rods, and bearing plates having mounting studs matching the fixture to be supported.
 - b. Type I:
 - 1) Provide hanger-type carriers having 2 vertical uprights.
 - c. Type II:
 - 1) Provide bi-level, hanger-type carriers having 3 vertical uprights.
 - d. Supports for Accessible Fixtures:
 - 1) Provide supports for accessible fixtures that include rectangular, vertical, steel uprights instead of steel pipe uprights.
 - e. Manufacturers:
 - 1) Josam Co., <http://www.josam.com>.
 - 2) MIFAB Manufacturing, Inc., <http://www.mifab.com>.
 - 3) Jay R. Smith Mfg. Co., <http://www.jrsmith.com>.
 - 4) Tyler Pipe, Wade Division, <http://www.wadedrains.com>.
 - 5) Watts Drainage Products Inc.; a div. of Watts Industries, Inc., <http://www.watts.com/pro/products.asp?catId=67>.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation, <http://www.zurn.com>.
 - 7) Approved equal.

2.02 ACCESSORIES

- A. Hangers and Supports:
 - 1. Provide pipe hangers and supports complying with the requirements specified in Section 15060, Hangers and Supports.
- B. Domestic Water Piping:



1. Provide domestic water piping complying with the requirements specified in Section 15140, Domestic Water Piping.
- C. Sanitary Waste and Vent Piping:
 1. Provide sanitary waste and vent piping complying with the requirements specified in Section 15150, Sanitary Waste and Vent Piping.
- D. Valves:
 1. Provide valves complying with the requirements specified in Section 15110, Valves.
- E. Escutcheons:
 1. Provide escutcheons complying with the requirements specified in Section 15050, Basic Mechanical Materials and Methods.
- F. Sealants:
 1. Provide sealants complying with the requirements specified in Section 07920, Joint Sealants.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Before installing the drinking fountains and water coolers, examine the roughing-in Work for water and for waste piping systems to verify the actual locations and sizes of the piping connections match those indicated on the Contract Drawings.
 - a. If roughing-in data are not indicated on the Contract Drawings, use the manufacturer's roughing-in data.
 2. Examine walls and floors where drinking fountains and water coolers are to be installed for suitable conditions.
- B. Evaluation and Assessment:
 1. Proceed to install the drinking fountains and water coolers only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the drinking fountains and water coolers.
- B. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.



3.03 INSTALLATION

- A. Fixture Supports:
 - 1. For wall-mounted drinking fountain and water cooler fixtures, affix off-floor supports to the building substrate, and attach the wall-mounted fixtures to the off-floor supports unless otherwise indicated in the Contract Documents.
 - 2. For recessed water coolers, affix mounting frames to the building construction, and attach the recessed water coolers to the mounting frames unless otherwise indicated in the Contract Documents.
 - 3. Install the drinking fountain and water cooler fixtures level and plumb.
- B. Interface with Other Work:
 - 1. Wall Penetrations:
 - a. In exposed, finished locations, provide pipe escutcheons at wall penetrations.
 - 1) Where required to conceal protruding pipe fittings, provide deep-pattern escutcheons.
 - 2. Wall and Floor Interfaces
 - a. Seal the joints between drinking fountain and water cooler fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant.
 - b. Match the sealant color to the fixture color.
- C. Systems Integration:
 - 1. Piping Connections:
 - a. Install piping in accordance with the requirements specified in other Sections where the piping is specified.
 - 1) Provide the size pipe fittings as required to match the drinking fountain and water cooler fixtures.
 - b. Water Supply Piping:
 - 1) Connect the drinking fountain and water cooler fixtures with the water supplies, stops, and risers.
 - 2) Install a shutoff valve on the water-supply piping to each drinking fountain and water cooler fixture to be connected to the water distribution piping.
 - a) Provide ball, gate, or globe valves.
 - b) Install the valves in locations where they can be easily reached for operation.
 - c. Waste Piping:
 - 1) Connect the drinking fountain and water cooler fixtures with the traps, soil, waste, and vent piping.
 - 2) Install the trap and waste piping on the drain outlet of each drinking fountain and water cooler fixture to be connected to sanitary drainage system.
 - 2. Electrical Connections:



- a. Power, Signal, and Control Wiring:
 - 1) Connect the wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.
- b. Electrical Grounding:
 - 1) Ground the drinking fountain and water cooler equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.

3.04 REPAIR/RESTORATION

- A. Repair damaged finishes so they match the original finishes.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Water Cooler Test:
 - a. Test Procedure:
 - 1) After the electrical circuitry for the drinking fountain and water cooler equipment has been energized, test the drinking fountain and water cooler equipment for compliance with the requirements specified herein.
 - a) Test and adjust the controls and safeties.
 - 2) Record the test results in writing, and submit these Water Cooler Test results to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Drinking fountain and water cooler equipment complying with the requirements specified herein pass the Water Cooler Test.
 - 2. Inspections:
 - a. After completing installation of each drinking fountain and water cooler fixture, inspect the installed unit.
- B. Non-Conforming Work
 - 1. Remove and replace malfunctioning units, and retest the replacement units as specified herein.

3.06 ADJUSTING

- A. Adjust the fixture flow regulators so the proper flow and stream height are produced.
- B. Adjust the water cooler temperature settings so the proper temperatures are produced.

3.07 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris from the installed drinking fountains and water coolers.



- B. After installing the drinking fountains and water coolers, clean them in accordance with their manufacturer's cleaning instructions.
 - 1. Submit the drinking fountain and water cooler manufacturer's written cleaning instructions to the Program/Project manager for information.
- C. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 PROTECTION

- A. Protect installed drinking fountains and water coolers from damage and wear during the remainder of the construction period.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data for the drinking fountains and water coolers to the Program/Project Manager for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15485

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Commercial electric booster heaters.

1.02 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA-90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.



1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion:
 - a. Electric Water Heaters: Five years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 COMMERCIAL ELECTRIC BOOSTER HEATERS

- A. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.
 1. Manufacturers:
 - a. Bradford White Corporation.
 - b. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - c. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - d. Smith, A. O. Water Products Company.
 2. Storage-Tank Construction: Corrosion-resistant metal or steel.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - b. Insulation: Comply with ASHRAE/IESNA 90.1.



- c. Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.
 - d. Heating Element: Electric, screw-in immersion type.
 - e. Temperature Control: Adjustable thermostat with setting as listed on drawings.
 - f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - g. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction with brackets for wall installation.
5. Capacity and Characteristics:
- a. Capacity and characteristics as scheduled on drawings.

PART 3 - EXECUTION

3.01 WATER HEATER INSTALLATION

- A. Install commercial water heaters on wall as shown on plans.
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.
- E. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- F. Fill water heaters with water.



3.02 CONNECTIONS

- A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.03 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections.
- B. Perform the following field tests and inspections:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15623

CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for packaged, water-cooled, electric-motor-driven, centrifugal water chillers.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 – Commissioning.
 - 6. Section 03100 - Concrete Forms and Accessories.
 - 7. Section 03200 - Concrete Reinforcement.
 - 8. Section 03300 - Cast-In-Place Concrete.
 - 9. Section 15070 – Mechanical Sound, Vibration, and Seismic Control.
 - 10. Section 15182 – Hydronic Piping.
 - 11. Section 15186 – Refrigerant Piping.
 - 12. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. BACnet: Building automation and control networks.
 - 3. BAS: Building automation system.
 - 4. dBA: Decibels; a weighted scale for measuring sound pressure in decibels that uses filters to reduce the contributions of low and high frequency sound referred to as the “A” weighted sound pressure level, referenced to the A-weighting filter curve defined in IEC 61672.
 - 5. GFI: Ground fault interrupt.
 - 6. TEAO: Totally enclosed air over.
 - 7. TENV: Totally enclosed non-ventilating.
- B. Definitions:
 - 1. British Thermal Unit or Btu: A measure of energy defined as the amount of heat required to raise the temperature of one pound of water one-degree Fahrenheit.



2. COP: Coefficient of performance; the ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
3. EER: Energy-efficiency ratio; the ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of Watts at any given set of rating conditions.
4. IPLV: Integrated part-load value; a single number part-load efficiency figure of merit calculated in accordance with the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
5. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
6. NPLV: Nonstandard part-load value; a single number part-load efficiency figure of merit calculated in accordance with the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
7. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - a. AHRI General OM – General Operations Manual for ARI Certification Programs.
 - b. ANSI/AHRI 370 – Standard for Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment.
 - c. AHRI 550/590 – Standard for Performance Rating Of Water-Chilling Packages Using The Vapor Compression Cycle.
 - d. AHRI OM 550/590 - Water-Chilling Packages Using The Vapor Compression Cycle Certification Program Operational Manual.
2. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE 15 - Safety Standard for Refrigeration Systems.
 - b. ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants.
 - c. ANSI/ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - d. ASHRAE/IESNA 90.1-2004 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - e. ANSI/ASHRAE 135 – A Data Communications Protocol for Building Automation and Control Networks (BACnet).
 - f. ANSI/ASHRAE 135.1 – Method of Test for Conformance to BACnet.
3. American Society of Mechanical Engineers (ASME):



- a. ASME BPVC-V - ASME Boiler and Pressure Vessel Code - Section V: Nondestructive Examination.
- b. ASME BPVC-VIII-1 - ASME Boiler and Pressure Vessel Code - Section VIII: Rules for Construction of Pressure Vessels Division 1.
- c. ASME BPVC-IX - ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.
- d. ASME BPVC-LABEL – BPVC Identification Label.
4. ASTM International (ASTM):
 - a. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - b. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. International Electrotechnical Commission (IEC):
 - a. IEC 60947-4-1 – Low-Voltage Switchgear and Controlgear – Part 4: Contactors and Motor-Starters – Electromechanical Contactors and Motor Starters.
 - b. IEC 61672 – Electroacoustics – Sound Level Meters – Part 2: Pattern Evaluation Tests.
8. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
9. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
 - a. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
 - b. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
10. Structural Engineering Institute (SEI)/American Society of Civil Engineers (ASCE):
 - a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
11. Underwriters Laboratories, Inc. (UL).
 - a. UL 1995 - Heating and Cooling Equipment.
 - b. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Notify the Program/Project Manager 14 days in advance of factory performance testing.
2. Coordination Drawings:
 - a. Prepare Coordination Drawings, including floor plans and other details drawn to scale, which show the following items coordinated with each other using input from the installers of the items involved:
 - 1) Structural supports.
 - 2) Piping roughing-in requirements.
 - 3) Wiring roughing-in requirements, including spaces reserved for electrical equipment.
 - 4) Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
 - 5) Coordinate the sizes and locations of concrete bases with the actual equipment provided.
 - 6) Coordinate the sizes, locations, and anchoring attachments of structural-steel support members, if any, with the actual equipment provided.
 - b. Submit the Coordination Drawings to the Program/Project Manager for approval.

B. Sequencing:

1. Install concrete bases and anchorage devices prior to installing the centrifugal water chillers.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Centrifugal water chiller.
 - b. Shop Drawings:
 - 1) Centrifugal water chillers.
 - c. Certificates:



1) Seismic Qualification Certificates.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Manufacturer's Instructions:

- 1) Manufacturer's recommended clearances for service and maintenance.
- 2) Centrifugal water chiller manufacturer's published installation instructions.
- 3) Centrifugal water chiller manufacturer's written installation and startup checks.

b. Source Quality Control Submittals:

- 1) Source quality-control test reports.

c. Manufacturer's Reports:

- 1) Startup service report.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Operation and Maintenance Data:

- 1) Operation and maintenance data for the centrifugal water chillers.

b. Warranty Documentation:

- 1) Centrifugal Water Chillers Warranty.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Arrange for obtaining the permits and schedule the inspections needed to install, commission, and startup the centrifugal water chillers system.

- a. After award of Contract, submit the centrifugal water chillers manufacturer's compliance review documents for the system to the Program/Project Manager and the Authorities Having Jurisdiction for approval.

B. Certifications:

1. Seismic Qualification Certificates:

- a. Have the manufacturer prepare Seismic Qualification Certificates certifying that the centrifugal water chillers, accessories, and components will withstand the seismic forces defined in Section 15070, Mechanical Sound, Vibration, and Seismic Control.

- 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.



- 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
- 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
- b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.
2. Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certification:
 - a. Factory-test the centrifugal water chillers and their components in accordance with the requirements of the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certification Program in order to have the centrifugal water chillers listed and labeled by the AHRI.
 - 1) Provide centrifugal water chillers that have been tested and certified in accordance with the requirements of the AHRI Water Chilling Packages (Air Cooled) Certification Program specified in AHRI General OM, AHRI OM 550/590, and AHRI 550/590.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ship the water chillers from the factory fully charged with refrigerant, and filled with oil.
- B. Storage and Handling Requirements:
 1. Furnish instructions in English for storing and protecting the centrifugal water chiller system equipment and components.
 2. Prior to installation, remove obstructions and debris from inside the piping systems.
- C. Packaging Waste Management:
 1. Remove shipping, blocking, and bracing materials.
 - a. Remove the loose packing materials and protective wrapping such as shrink-wrap, wood crating, and packing from the centrifugal water chillers as required.
 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Manufacturer Warranty:
 1. Centrifugal Water Chillers Warranty:



- a. Warrant the centrifugal water chillers against defects within the 5-year period after the Date of Substantial Completion:
 - 1) Submit a Centrifugal Water Chillers Warranty on the centrifugal water chiller manufacturer's standard or customized form, without monetary limitation, in which the centrifugal water chiller manufacturer agrees to replace centrifugal water chillers that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 CENTRIFUGAL WATER CHILLER SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - b. Manufacturers:
 - 1) York, <http://www.johnsoncontrols.com>.
 - 2) McQuay International, <http://www.mcquay.com>.
 - 3) Trane, <http://www.trane.com>.
 - 4) Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) Compliance:
 - 1) Provide centrifugal water chillers complying with the requirements of the safety code for mechanical refrigeration specified in ANSI/ASHRAE 15.
 - 2) Provide centrifugal water chillers complying with the applicable requirements in Section 6, Heating, Ventilating, and Air-Conditioning, of ASHRAE/IESNA 90.1-2004.
 - c. American Society of Mechanical Engineers (ASME) Compliance:



- 1) Provide centrifugal water chiller heat exchangers fabricated and stamped in compliance with ASME BPVC-VIII-1, ASME BPVC-IX, and ASME BPVC-LABEL.
 - a) Provide evaporators that have been tested and stamped in accordance with the requirements specified in the ASME Boiler and Pressure Vessel Code.
- d. National Electrical Code (NEC):
 - 1) Provide electrical products and installation complying with the requirements specified in NFPA 70.

C. Performance:

1. Capacities and Characteristics:

- a. Provide magnetic bearings centrifugal water chillers having the capacities, characteristics, and accessories indicated in the Mechanical Equipment Schedule on the Contract Drawings.
- b. Full-Load Efficiency:
 - 1) Coefficient of Performance (COP): x.xx.
- c. Part-Load Efficiency:
 - 1) Integrated Part-Load Value (IPLV): x.xx.
- d. Low Ambient Operation:
 - 1) Provide centrifugal water chillers designed for operation down to 0 degrees Fahrenheit (minus 18 degrees Celsius).
- e. High Ambient Operation:
 - 1) Provide centrifugal water chillers designed for operation up to 115 degrees Fahrenheit (46 degrees Celsius).
- f. Evaporator Configuration:
 - 1) Provide centrifugal water chillers having an evaporator configuration integral to the chiller.
- g. Evaporator & Condenser Pressure Rating:
 - 1) Provide centrifugal water chillers having an evaporator pressure rating of 300 psig.
- h. Evaporator & Condenser Fluid Type:
 - 1) Provide centrifugal water chillers designed to use water as the evaporator & condenser fluid.
- i. Design Evaporator Fluid Flow Rate:
 - 1) Provide centrifugal water chillers designed for an evaporator fluid flow rate of 513 gallons per minute.
- j. Minimum Evaporator Fluid Flow Rate:
 - 1) Provide centrifugal water chillers designed for a minimum evaporator fluid flow rate of XXX gallons per minute.
- k. Evaporator Entering-Fluid Temperature:
 - 1) Provide centrifugal water chillers designed for an evaporator entering-fluid temperature of 58 degrees Fahrenheit.



- I. Evaporator Leaving-Fluid Temperature:
 - 1) Provide centrifugal water chillers designed for an evaporator leaving-fluid temperature of 44 degrees Fahrenheit.
- m. Evaporator Fluid Pressure Drop:
 - 1) Provide centrifugal water chillers designed for an evaporator fluid pressure drop of 16.3 feet of head.
- n. Evaporator Fouling Factor:
 - 1) Provide centrifugal water chillers designed using an evaporator fouling factor of 0.0001 square foot-hour-degree Fahrenheit per British thermal unit ($\text{ft}^2 \times \text{hr.} \times ^\circ\text{F} / \text{Btu}$).
- o. Condenser Entering-Fluid Temperature:
 - 1) Provide centrifugal water chillers designed for a condenser entering-fluid temperature of 85 degrees Fahrenheit.
- p. Condenser Leaving-Fluid Temperature:
 - 1) Provide centrifugal water chillers designed for a condenser leaving-fluid temperature of 95 degrees Fahrenheit.
- q. Site Altitude:
 - 1) Provide centrifugal water chillers designed to operate at an altitude of 1100 feet above mean sea level.
- r. Number of Refrigeration Circuits:
 - 1) Provide centrifugal water chillers designed to have x refrigeration circuits.
- s. Compressor Rated Load Amperes:
 - 1) Provide centrifugal water chiller compressors rated for a load of xx Amperes.
- t. Compressor Locked-Rotor Amperes:
 - 1) Provide centrifugal water chiller compressors rated for a locked-rotor load of xxx Amperes.
- u. Controls Power Connection:
 - 1) Provide centrifugal water chillers having their controls power connection fed through an integral transformer.
 - 2) Controls Power Input:
 - a) Provide centrifugal water chiller controls having a power input of x.x Ampere.
 - 3) Controls Minimum Circuit Ampacity:
 - a) Provide centrifugal water chiller control circuits having an ampacity of at least xx Amperes.
 - 4) Controls Maximum Overcurrent Protection Device:
 - a) Provide centrifugal water chiller controls having an overcurrent protection device rated for no more than xx Amperes.
 - 5) Controls Electrical Characteristics:



- a) Provide centrifugal water chiller controls designed to operate on single phase, 60 Hertz, 120-Volts AC power.
 - v. Chiller Power Input:
 - 1) Provide centrifugal water chillers designed for a power input of 159.7 kilowatts.
 - w. Chiller Minimum Circuit Ampacity:
 - 1) Provide centrifugal water chiller circuits having an ampacity of not less than 262 Amperes.
 - x. Chiller Maximum Overcurrent Protection Device:
 - 1) Provide centrifugal water chillers having an overcurrent protection device rated for no more than 450 Amperes.
 - y. Chiller Electrical Characteristics:
 - 1) Provide centrifugal water chillers designed to operate on three - phase, 60 Hertz, 480-Volts AC power.
 - z. Noise Rating:
 - 1) Provide centrifugal water chillers having a noise rating of 92 dBA when measured in accordance with the method specified in ANSI/AHRI 370.
 - 2. Seismic Performance:
 - a. Provide centrifugal water chillers capable of withstanding the effects of earthquake motions determined in accordance with the procedures specified in ASCE/SEI 7.
 - 1) The phrase "capable of withstanding" is hereby defined to mean the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
 - b. Fabricate the base, frame, and attachment to water chiller components so they are strong enough to resist movement during a seismic event when the water chiller base is anchored to the field support structure.
- D. Design Criteria:
- 1. Provide factory-assembled and run-tested water chillers complete with a base and frame, a condenser casing, compressors, compressor motors and motor controllers, evaporators, condenser coils, condenser fans and motors, electrical power, controls, and accessories. The entire chiller package shall be UL listed.
 - 2. AHRI Rating:
 - a. Rate the water chiller performance in accordance with the requirements specified in AHRI 550/590.
 - 3. Product Data:



- a. Obtain the centrifugal water chiller manufacturer's Product Data, including refrigerant information, rated capacities, operating characteristics, furnished specialties, accessories, and the following:
 - 1) Performance at AHRI standard conditions and at the conditions specified herein.
 - 2) Performance at AHRI standard unloading conditions.
 - 3) Minimum evaporator flow rate.
 - 4) Refrigerant capacity of the water chiller.
 - 5) Oil capacity of the water chiller.
 - 6) Fluid capacity of the evaporator.
 - 7) Characteristics of the safety relief valves.
 - 8) Minimum entering condenser-air temperature.
 - 9) Performance at varying capacity with constant design entering condenser-air temperature.
 - a) Indicate the performance for different entering condenser-air temperatures for varying capacity from the design capacity to the minimum capacity in 10-degree Fahrenheit (6-degree Celsius) increments.
 - b. Submit the Product Data for the centrifugal water chillers to the Program/Project Manager for approval.
4. Shop Drawings:
- a. Prepare Shop Drawings for the centrifugal water chillers that include a complete set of the centrifugal water chiller manufacturer's drawings of the water chiller assemblies, control panels, sections and elevations, and unit isolation.
 - 1) Include the assembled unit's dimensions, weight, and load distribution.
 - 2) Include the required clearances for maintenance and operation.
 - 3) Include the size and location of piping and wiring connections.
 - 4) Include wiring diagrams for power, signal, and control wiring.
 - b. Submit the Shop Drawings for the centrifugal water chillers to the Program/Project Manager for approval.
- E. Operation:
1. Controls:
 - a. Provide stand-alone, microprocessor-based controls.
 - b. Control Enclosure:
 - 1) Provide an enclosure sharing space with the electrical power devices, or provide a separate enclosure of matching the construction of the electrical power enclosure.
 - c. Operator Interface:
 - 1) Provide an operator interface consisting of either a keypad or pressure-sensitive touch screen.



- 2) Display:
 - a) Provide either a multiple-character, backlit, liquid-crystal display, or light-emitting diodes, capable of displaying the following information:
 - (1) The date and time.
 - (2) Operating or alarm status.
 - (3) Operating hours.
 - (4) The outside-air temperature, if required for a chilled-water reset.
 - (5) The temperature and pressure of the operating set points.
 - (6) The entering and leaving temperatures of the chilled water.
 - (7) The refrigerant pressures in the evaporator and condenser.
 - (8) The saturation temperature in the evaporator and condenser.
 - (9) No cooling load condition.
 - (10) Elapsed time meter (compressor run status).
 - (11) Pump status.
 - (12) Anti-recycling timer status.
 - (13) Percent of maximum motor amperage.
 - (14) Current-limit set point.
 - (15) Number of compressor starts.
- d. Control Functions:
 - 1) Provide controls capable of setting/controlling the following functions:
 - a) Manual or automatic startup and shutdown time schedule.
 - b) Entering and leaving chilled-water temperatures, control set points, and motor load limit.
 - (1) Reset the chilled-water leaving temperature based on the outside-air temperature.
 - c) Current limit and demand limit.
 - d) External water chiller emergency stop.
 - e) Anti-recycling timer.
 - f) Automatic lead-lag switching.
- e. Manual-Reset Safety Controls:
 - 1) Provide controls capable of shutting down the water chiller and requiring a manual reset: when the following conditions occur:
 - a) Low evaporator pressure or high condenser pressure.
 - b) Low chilled-water temperature.
 - c) Refrigerant high pressure.
 - d) High or low oil pressure.
 - e) High oil temperature.



- f) Loss of chilled-water flow.
 - g) Control device failure.
 - f. Building Automation System Interface:
 - 1) To enable the building automation system (BAS) to monitor, control, and display water chiller status and alarms, provide factory-installed hardware and software.
 - 1) Building Automation and Control Networks (BACnet):
 - a) To enable the building automation system (BAS) operator to remotely control and monitor the water chiller from an operator workstation, provide a communication interface with the building automation system complying with the requirements specified in ANSI/ASHRAE 135.
 - b) Make the control features and monitoring points displayed locally at the water chiller control panel available through the building automation system (BAS).
- F. Components:
 - 1. Cabinet:
 - a. Cabinet Base:
 - 1) Provide a galvanized-steel cabinet base extending around the perimeter of the water chiller.
 - 2) Secure the frame, compressors, and evaporator to the cabinet base so a single-piece unit results.
 - b. Cabinet Frame:
 - 1) Provide a rigid galvanized-steel cabinet frame secured to the cabinet base, and designed to support the cabinet, condenser, control panel, and other chiller components not directly supported from the cabinet base.
 - c. Cabinet Casing:
 - 1) Provide a galvanized steel cabinet casing.
 - d. Cabinet Finish:
 - 1) Coat the cabinet base, cabinet frame, and cabinet casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test performed in accordance with the method specified in ASTM B 117.
 - e. Sound-Reduction Package:
 - 1) To reduce the sound level of the centrifugal water chillers without affecting their performance, provide a sound-reduction package consisting of an acoustic enclosure around the compressors and reduced-speed fans having acoustic treatments.
 - f. Security Package:
 - 1) To furnish additional protection of the centrifugal water chiller compressors, evaporator, and condenser coils and to furnish



- access for service, provide a security package consisting of removable security grilles having fasteners.
- 2) Coat the grilles to provide corrosion resistance.
2. Compressors:
- a. Provide multi-stage direct drive centrifugal type compressors powered by high speed electric motors.
 - b. A cast aluminum, fully shrouded impeller shall be mounted directly to the motor shaft.
 - c. The impeller shall be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration-free operation.
 - d. Compressor castings shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for HFC R-134A units.
 - e. Capacity Control:
 - 1) Capacity control shall be achieved by the combined use of variable speed and variable diffuser geometry to provide fully modulating control from maximum to minimum load while maintaining constant chiller leaving water temperature.
3. Compressor Motors:
- a. The motor shall be a semi-hermetic, oil free, permanent magnet type directly coupled to the compressor.
 - b. The motor shall be bolted to a cast iron adapter plate mounted on the compressor to provide factory alignment of the shaft.
 - c. The motor shaft shall be supported on active magnetic radial and thrust bearings.
 - d. Magnetic bearing control shall be equipped with auto vibration reduction and balancing systems. During a power failure event, the magnetic bearings shall remain active throughout the compressor coast down.
 - e. Rolling element bearings shall be provided as a backup to the magnetic bearings designed for emergency touch down situations.
 - f. Motor stator and rotor shall be equipped with a pressure driven refrigerant cooling loop to maintain acceptable operating temperatures.
4. Variable Speed Drive:
- a. A variable speed drive shall be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and compressor diffuser geometry for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.
 - b. Drive shall be PWM type utilizing IGBT's with a power factor of 0.97 or better at all loads and speeds.
 - c. The variable speed drive shall be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed.



- d. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided.
- 5. Refrigeration:
 - a. Refrigerant:
 - 1) Provide HFC R-134A refrigerant classified in accordance with the requirements for Safety Group A1 specified in ANSI/ASHRAE 34.
 - b. Refrigerant Flow Control:
 - 1) Refrigerant flow to the evaporator shall be controlled by a variable orifice for improving unloading capabilities. The variable orifice control shall automatically adjust to maintain proper refrigerant level in the condenser and evaporator. This shall be controlled by monitoring refrigerant liquid level in the condenser, assuring optimal sub-cooler performance.
 - 2) Provide parts exposed to refrigerants that are fully compatible with the refrigerants, and rate pressure components for the refrigerant pressures.
- 6. Evaporators:
 - a. Provide a shell-and-tube evaporator, hybrid falling film type designed for 235 psig working pressure on the refrigerant side.
 - b. Shell and Tube Evaporator Design:
 - 1) Provide a direct-expansion, shell-and-tube evaporator design having fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
 - 2) Shell:
 - a) Shell shall be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1.
 - 3) Tube:
 - a) Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 fps. A liquid level sight glass will be located on the side of the shell to aid in determining proper refrigerant charge. A suction baffle eliminator will be located above the tube bundle to prevent liquid refrigerant carryover to the compressor. The evaporator shall have a refrigerant relief device sized to meet



- the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.
- b) Provide individually replaceable copper tubes having an enhanced fin design that is expanded into tube sheets.
 - c. Water boxes shall be removable to permit tube cleaning and replacement. Stub-out water connections having Victaulic grooves shall be provided. Water boxes shall be designed for 150psi (10.3 bar) design working pressure and tested at 225 psig (15.5 bar). Vent and drain connections with plugs will be provided on each water box. Low flow protection shall be provided by a thermal-type flow sensor, factory mounted in the water nozzle connection and wired to the chiller control center.
 - d. Low Ambient Temperature Controls (Heater):
 - 1) Provide a factory-installed and factory-wired electric heater having integral controls designed to protect the evaporator down to 0 degrees Fahrenheit (minus 18 degrees Celsius).
 - e. High Ambient Temperature Controls:
 - 1) Provide high ambient temperature controls that include field-mounted discharge pressure transducers designed for operation up to 115 degrees Fahrenheit (46 degrees Celsius).
7. Water-cooled Condensers:
- a. Condenser shall be of the shell-and-tube type, designed for 235 psig working pressure on the refrigerant side.
 - b. Shell shall be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart.
 - c. The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1.
 - d. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 fps.
 - e. Water boxes shall be removable to permit tube cleaning and replacement. Stub-out water connections having ANSI/AWWA C-606 grooves will be provided. Water boxes shall be designed for 150 psi (10.3 bar) design working pressure and tested at 225 psig (15.5 bar). Vent and drain connections with plugs will be provided on each water box.



8. Electrical Power:
 - a. Provide a single-point field power connection to the water chiller necessary to furnish electrical power for the factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices.
 - b. Enclosure:
 - 1) House the centrifugal water chiller field power connection in a unit-mounted, NEMA Type 3R enclosure complying with the requirements specified in NEMA 250, and having a hinged access door with a lock and key or padlock and key.
 - 2) Provide raceway for factory wiring located outside of an enclosure.
 - c. Wiring Identification:
 - 1) Number and color-code the wiring to match the identification indicated in the approved wiring diagram.
 - d. Disconnecting Means:
 - 1) Field Power Interface Disconnecting Means:
 - a) Provide a heavy-duty, nonfused disconnect switch complying with the requirements specified in NEMA KS 1, and connected to the field power interface.
 - 2) Branch Power Circuit Disconnecting Means:
 - a) Provide one of the following disconnecting means for each branch power circuit to each motor and to the controls:
 - (1) Provide a heavy-duty, fusible switch complying with the requirements specified in NEMA KS 1, and having rejection-type fuse clips rated for the size of the fuses.
 - (a) Select and size the fuses in accordance with the requirements for providing Type 2 protection specified in IEC 60947-4-1.
 - (2) Provide a heavy-duty, non-fusible switch complying with the requirements specified in NEMA KS 1.
 - (3) Provide a motor-circuit protector (circuit breaker) complying with the requirements specified in NEMA AB 1, and having a field-adjustable, short-circuit trip coordinated with the motor locked-rotor amperes.
 - e. Motor Overcurrent Protection:
 - 1) Provide motors each having overcurrent protection.
 - f. Overload Relays:
 - 1) Provide overload relays sized in accordance with the requirements specified in UL 1995, or that are an integral component of the water chiller control microprocessor.
 - g. Phase-Failure and Under Voltage:



- 1) Provide solid-state phase-failure and under voltage sensing having adjustable settings.
 - h. Power Factor Correction:
 - 1) Provide power factor correction capacitors to correct the power factor to 0.95 at full load.
 - i. Transformers:
 - 1) Provide a unit-mounted transformer having primary and secondary fuses, and sized with enough capacity to operate the electrical load plus spare capacity.
 - a) Provide power for unit-mounted controls where indicated in the Contract Documents.
 - b) Provide a power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
 - j. Control Relays:
 - 1) Provide auxiliary and adjustable time-delay control relays.
 - k. Indications:
 - 1) For the water chiller electrical power supply, provide indication of the following parameters:
 - a) Current, phase to phase, for all three phases.
 - b) Voltage, phase to phase and phase to neutral for all three phases.
 - c) Three-phase real power (kilowatts).
 - d) Three-phase reactive power (kilovolt amperes reactive).
 - e) Power factor.
 - f) Running log of total power versus time (kilowatt hours).
 - g) Fault log, having the time and date of each fault.
9. Thermal Insulation:
 - a. Factory-apply thermal insulation over the cold surfaces of the water chiller components.
 - b. Provide closed-cell, flexible elastomeric, thermal insulation complying with the requirements specified in ASTM C 534.
 - 1) For tubular materials, provide Type I thermal insulation.
 - 2) For sheet materials, provide Type II thermal insulation.
 - c. Thermal Insulation Thickness:
 - 1) Provide 3/4-inch thick (18mm) thermal insulation.
 - d. Thermal Insulation Adhesive:
 - 1) Provide the thermal insulation adhesive recommended by the insulation manufacturer.
 - 2) Apply thermal insulation adhesive to 100 percent of the insulation contact surface.
 - 3) Seal the seams and joints.
 - e. Apply a protective coating to the exposed surfaces of the insulation.



2.02 ACCESSORIES

- A. Flow Switches:
 - 1. Provide factory-furnished, chilled-water and condenser-water flow switches for field installation.
- B. Pressure Gages:
 - 1. For each refrigeration circuit, provide individual compressor suction and discharge pressure gages having shutoff valves.
- C. Isolators:
 - 1. Provide factory-furnished neoprene isolators for field installation.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Products and components specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.
 - a. Fourteen days before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.
 - b. Prepare source quality control test reports documenting the results of the source quality control tests, and submit them to the Program/Project manager for information.
 - 2. Functional Test:
 - a. Test Procedure:
 - 1) Before shipping the centrifugal water chillers to the Site, perform a functional test of the water chillers.
 - b. Acceptance Criteria:
 - 1) Centrifugal water chillers that properly perform the functions specified pass the Functional Test.
 - 3. Performance Test:
 - a. Test Procedure:
 - 1) Before shipping the centrifugal water chillers to the Site, perform a performance test of the water chillers in accordance with the methods specified in AHRI 550/590.
 - 2) Allow the Program/Project Manager access to the place where the centrifugal water chillers are being performance tested.
 - b. Acceptance Criteria:
 - 1) Centrifugal water chillers that properly perform as specified in AHRI 550/590 for the type of unit tested pass the Performance Test.



4. Evaporator Test:
 - a. Test Procedure:
 - 1) Factory test and inspect the centrifugal water chiller evaporator in accordance with the requirements specified in ASME BPVC-VIII-1.
 - b. Acceptance Criteria:
 - 1) Centrifugal water chillers that comply with the requirements for stamping the evaporator with the American Society of Mechanical Engineers (ASME) label pass the Evaporator Test.
5. Sound Power Level Test:
 - a. Test Procedure:
 - 1) For centrifugal water chillers located outdoors, determine the sound power level rating in accordance with the procedure specified in ANSI/AHRI 370.
 - b. Acceptance Criteria:
 - 1) Centrifugal water chillers having properly determined sound power level rating complying with the specified requirement pass the Sound Power Level Test.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Before installing the centrifugal water chillers, examine the roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections at the installation location to verify the actual locations, sizes, and other conditions affecting the centrifugal water chiller performance, maintenance, and operations.
 - a. Centrifugal water chiller locations indicated on the Contract Drawings are approximate.
 - b. Determine the exact locations before roughing-in piping and electrical connections.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the centrifugal water chillers.



B. Surface Preparation:

1. Concrete Bases:

- a. If concrete pads are required to support the centrifugal water chillers, provide flat concrete pads constructed in accordance with the seismic-restraint requirements specified in Section 15060, Hangers and Supports.
 - 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the walk-in medium-voltage substation switchgear.
 - 2) Extend the base no less than 4 inches in all directions beyond the maximum dimensions of the centrifugal water chillers, unless otherwise indicated on the Contract Drawings, or unless required for seismic anchor support.
 - 3) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.
 - 4) Install dowel rods to connect the concrete housekeeping pad to the concrete floor slab.
 - a) Unless otherwise indicated in the Contract Drawings, install dowel rods on 18-inch (450mm) centers around the full perimeter of concrete slab.
- b. Place and secure anchorage devices.
 - 1) Design each fastener and support in accordance with the seismic-restraint requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control, to carry the load indicated by seismic requirements and according to seismic-restraint details.
 - 2) Install anchor bolts to the elevations required for proper attachment to the centrifugal water chillers.
 - a) Install epoxy-coated anchor bolts that extend through the concrete base and anchor into the structural concrete floor.
 - b) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - c) Cast anchor-bolt inserts into the concrete bases.

3.03 INSTALLATION

A. Equipment Mounting:

1. Install the centrifugal water chillers on the support structure indicated on the Contract Drawings.



- a. If concrete pads are required to support the centrifugal water chillers, install the water chiller on the concrete bases using elastomeric pads.
 - b. Comply with the requirements for vibration isolation devices specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
 - 1) Minimum Deflection:
 - a) Provide vibration isolation devices having a minimum deflection of 1/4 inch (6mm).
 2. Maintain the manufacturer's recommended clearances for service and maintenance.
 - a. Submit the manufacturer's recommended clearances for service and maintenance to the Program/Project manager for information.
- B. Install the centrifugal water chillers in accordance with the manufacturer's installation instructions.
1. Submit the centrifugal water chiller manufacturer's published installation instructions to the Program/Project Manager for information.
 2. If the centrifugal water chiller was not factory-charged with refrigerant or if the chiller did not receive the required lubrication at the factory, charge the water chiller with refrigerant and fill the appropriate lubrication fittings with oil.
 3. Install the separate devices furnished by the centrifugal water chiller manufacturer, and not factory-installed.
- C. Systems Integration:
1. Connections:
 - a. Piping Connections:
 - 1) The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - a) For water piping, comply with requirements specified in Section 15182, Hydronic Piping.
 - b) For refrigerant piping, comply with requirements specified in Section 15186, Refrigerant Piping
 - b. Install the piping adjacent to the chiller so space for service and maintenance is furnished.
 - c. Evaporator Fluid Connections:
 - 1) Connect the evaporator fluid connections to the evaporator inlet using a shutoff valve, a strainer, a flexible connector, a thermometer, and a plugged tee having a pressure gage.
 - 2) Connect the evaporator fluid connections to the evaporator outlet using a shutoff valve, a balancing valve, a flexible connector, a flow switch, a thermometer, a plugged tee having a pressure gage, and a drain connection having a valve.



- 3) Make the evaporator fluid connections to the water chiller using a flange.
- d. Refrigerant Pressure Relief Valve Connections:
 - 1) For water chillers installed indoors, extend the vent piping to the outside without valves or restrictions.
 - 2) Provide refrigerant pressure relief valve connections that comply with the requirements specified in ANSI/ASHRAE 15.
- e. Connect a union and drain pipe to each drain connection, and extend the pipe the full size of connection to the drain as shown on the Contract Drawings.
- f. If required, provide a shutoff valve at each connection.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Inspections:
 - a. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- B. Manufacturer Services:
 1. Engage a factory-authorized service representative to perform the startup service.

3.05 SYSTEM STARTUP

- A. Commissioning:
 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork, air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.
- B. The start-up and commissioning team, and the Program/Project Manager, will perform the operational tests to confirm system performance.
- C. Submit the centrifugal water chiller manufacturer's written installation and startup checks to the Program/Project Manager for information.
 1. Complete the installation and startup checks for the centrifugal water chillers in accordance with the centrifugal water chiller manufacturer's written instructions, and perform the following activities:



- a. Verify that the refrigerant charge is sufficient, and that the water chiller has been leak tested.
 - b. Verify that the pumps are installed and are functional.
 - c. Verify that the thermometers and gages are installed.
 - d. Operate the water chiller for the run-in period.
 - e. Verify proper motor rotation.
 - f. Verify the static deflection of the vibration isolators, including the deflection of the vibration isolators during water chiller startup and shutdown.
 - g. Verify and record the performance of the chilled-water flow, low-temperature, and high-temperature interlocks.
 - h. Verify and record the performance of the water chiller protection devices.
- D. Prepare a written startup service report that records the results of the tests and inspections.
- 1. Submit the startup service report to the Program/Project Manager.

3.06 ADJUSTING

- A. Test and adjust the centrifugal water chiller controls and safeties.
- 1. Replace damaged or malfunctioning controls and equipment.

3.07 CLEANING

- A. Waste Management:
- 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Training:
- 1. Engage a factory-authorized field service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the centrifugal water chillers in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- A. Take steps to ensure that installed centrifugal water chillers are protected during subsequent construction activities.
- 1. Using the units for temporary purposes during construction is unacceptable.



3.10 MAINTENANCE

A. Operation and Maintenance Data:

1. Submit operation and maintenance data for the centrifugal water chillers to the Program/Project Manager for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	04/06/2018	N/A	All	Revised by GF.





SECTION 15640

COOLING TOWERS

PART 1 GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of Contract," "Special Conditions" and "Division 1 – General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes packaged cooling tower with structure, casing, fill and basin, controls, heaters fans, motors and drive equipment, condensing water inlet and outlet with internal distribution and ladder and handrails.
- B. Related Sections:
 - 1. Section 03300 - Cast-In-Place Concrete: Execution requirements for concrete bases specified by this section.
 - 2. Section 15065 - Motors for Mechanical Equipment: Product requirements for electric drive motors for placement by this section.
 - 3. Section 15060 - Hangers and Supports for HVAC Piping and Equipment: Execution requirements for steel support bases specified by this section.
 - 4. Section 15070 – Mechanical Sound, Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 5. Section 15182 - Hydronic Piping: Product requirements for condenser water piping for placement by this section.
 - 6. Section 15188 - HVAC Water Treatment: Product and execution requirements for cooling tower water chemical treatment equipment.
 - 7. Section 16061 – Electrical Grounding and Bonding: Execution requirements for electrical connections specified by this section.

1.3 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.



- C. American Society of Mechanical Engineers:
 - 1. ASME PTC 23 - Atmospheric Water Cooling Equipment.
- D. ASTM International:
 - 1. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - 2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. Cooling Technology Institute:
 - 1. CTI - Acceptance Test Code.
 - 2. CTI 201 - Certification Standard for Commercial Water Cooling Towers.
- F. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate structural steel supports including dimensions and locations for mounting-bolt holes.
- C. Product Data: Submit rated capacities, dimensions, weights and point loads, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls. Submit performance curve plotting leaving water temperature against wet bulb temperature.
- D. Field Test Reports: Indicate compliance with specified performance.
- E. Manufacturer's Certificate: Certify cooling tower performance meets or exceeds specified requirements.
- F. Manufacturer's Field Reports: Submit start-up report. Indicate compliance with field test.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01770 - Closeout Procedures & Section 01780 – Closeout Submittals.
- B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories.



1.6 QUALITY ASSURANCE

- A. Construction and rating in accordance with CTI Acceptance Test Code and CTI 201.
- B. Performance Ratings: Required performance not less than prescribed by ASHRAE 90.1 when tested in accordance with CTI Acceptance Test Code and CTI 201.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum fifteen years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years' experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01316 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Follow manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Match mark disassembled components. Reinforce, brace and pack for shipment per applicable commerce requirements. Seal open ends subject to detrimental conditions with removable closures.
- C. Mark packed materials for identification. Show on shipping invoice, crate, box, carton or component identification, the Department's purchase order number and consignee's name and shipping address.
- D. Notify Department within 24 hours of shipment of equipment. The following information shall be supplied: shipping date, carrier PRO number, truck number, quantity, weights, items shipped, and estimated time of arrival.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.



1.11 WARRANTY

- A. Section 01780 - Closeout Submittals: Product warranties and product bonds.
- B. Upon completion, the manufacturer shall issue a written warranty, duly authorized, covering the following:
 - 1. The cooling tower structure and internal components shall be warranted against defects in material and workmanship and the systems shall meet operating conditions, capacity, and performance for the greater period of 18 months from the shipment of materials or 12 months from beneficial use by Department. The mechanical equipment and motors shall be warranted for 5 years from beneficial use. If either the unit or accessories fail to meet operating requirements or if failure of a part occurs during this warranty period, rework or replace items to meet the contract requirements at no cost to the Department.
- C. The Department reserves the option to request thermal or sound performance test per CTI Standards throughout the warranty period.

1.12 MAINTENANCE SERVICE

- A. Section 01770 - Closeout Procedures & Section 01780 – Closeout Submittals.: Requirements for maintenance service.

1.13 EXTRA MATERIALS

- A. Section 01770 - Closeout Procedures & Section 01780 – Closeout Submittals – Spare parts and maintenance products.
- B. Manufacturer shall furnish the Department with a complete set of the recommended spare parts. Include one change of gear drive oil, two spray nozzles for each cell and two gaskets for each access door.
- C. Provide two sets of any special tools required or recommended by Manufacturer for field maintenance.

PART 2 PRODUCTS

2.1 COOLING TOWERS

- A. Manufacturers:
 - 1. Marley.
 - 2. Baltimore Aircoil.
 - 3. Evapco.



- B. Product Description: factory assembled, sectional, cross-flow design, with fan and motor assemblies, built with pan, casing, fill and drift eliminators.

2.2 STEEL COOLING TOWERS

A. General:

1. Completely factory assembled, piped and wired, requiring no field assembly, with the exception of field installed accessories.
2. Suitable for installation in the space conditions indicated on drawings, including clearance for installation, operation, maintenance, and air flow into and out of tower. Cooling tower manufacturer shall certify tower for space conditions given.
3. The load and location of required cooling tower supports shall be provided by this manufacturer. Manufacturer shall design cooling tower and provide materials necessary for attachment to dunnage steel.
4. Vibration isolators shall be at least 1" thick neoprene pads located at points approved by manufacturer.
5. Tower design and materials of construction, including fill, shall have a design life expectancy of not less than 10 years for the geographical location and atmospheric conditions of the installation. Towers shall be bolted or with continuously welded basin construction. Spot welded construction is not permitted. Towers shall be designed for wind load as required by BOCA and in accordance with authorities having jurisdiction.
6. Except as noted, all components shall be PVC, galvanized steel, stainless steel, or FRP.
7. PVC fill shall be cross-corrugated 20 mil (before forming) thick sheets. Fill shall withstand a continuous 120oF continuous water temp, and a 130oF maximum water temperature. The fill shall be impervious to rot, decay, fungus and biological attack. Maximum flame spread and smoke developed ratings of 25 & 50 respectively.
8. PVC eliminators and louvers shall be 15 mil thick with maximum flame spread and smoke developed ratings of 25 & 50 respectively. Triple- pass drift eliminators shall be used.
9. Fans and drives: Except as noted, airflow shall be manually adjustable in the field through adjustable pitch fan blades. Fans shall be statically balanced in factory and properly supported to prevent damage in shipment and rigging. Drive shall be designed for minimum 150 percent of motor horsepower. Provide galvanized steel, stainless steel, or FRP guards for fans and drives. Acceptable fan and drives include:
 - a. Propeller fans: Cast aluminum. Fan blades shall connect to hubs using stainless steel Grade 8 bolts or approved alternate.
 - b. Gear drives: Right angled type suitable for cooling tower duty, provide oil level indicator and reservoir with fill and drain connections which shall be extended to the fan deck level for access. A five-year maintenance warranty shall be provided for gear drives. First oil change to be



provided by manufacturer. Gear drives will not require an external oil pump or require an electric internal pump. Vibration switch to be mounted on or near fan drive and shall disable motor in the event of a trip.

10. Distribution orifices and spray nozzles: Plastic, individually removable for cleaning or replacement, capable of passing a 1/4" sphere (minimum 5/16" opening).
11. Provide stainless steel distribution basin or corrosion resistant plastic distribution system to distribute water evenly over the tower fill. Provide two compartment water basins (or other engineered means) to provide balanced distribution flow across entire out-board face at reduced (50%) flow rate. Provide details of flow reduction method with proposal.
12. Fan and drive guards: Provide OSHA approved guards and screens around fans, drives and motors as necessary to protect people outside tower from injury due to moving parts. Provide warnings on access doors to caution operations as to hazards of moving parts.
13. Ladders, platforms, hand rails and access doors: Provide as necessary for ready access to all components, including balancing valves, hot water distribution basins or nozzles, cold water basin and all components located within it, motor lubrication fittings, gear oil level indicators, oil fill connections, oil drain valves, power band, etc. Gear oil level must be readable from the outside of the cell and/or during operation. Follow local, town, and state codes. Ladders shall extend to within 12" of access level (roof or platform). Ladder to fan deck shall be aluminum, with 1-1/4" steel pipe handrail around fan deck. Ladders, platforms and handrail shall conform to all OSHA requirements, including cages if ladders exceed 20 ft height or if shown on drawings. Provide access doors on both sides of casing and interior platforms to allow access through the interior of one tower cell to the adjacent tower cells. A galvanized steel access door shall be located on both endwalls for entry into the cold-water basin and fan plenum area. Access doors shall be operable from inside as well as outside the tower.
14. Connection points and cooling tower structure shall withstand forces imposed by rigging equipment of 2g horizontal and 3g vertical magnitudes with no compromise to the structural integrity of any components. The calculations shall be performed with the tower in the condition it will be delivered. Eye bolts or other approved means shall be provided for four-point rigging of tower.

B. Double flow, Cross flow, vertical discharge type:

1. Cold water basin: Welded 304 stainless steel for all components, including collection basin bottom and sides, flanged inlet connections as shown on drawings, bolts and nuts. Basin to be set up to drain by gravity to location approved by Department. Condenser water headers and distribution system shall be internal to the cooling tower structure with external flanged



connections. All connections to system piping to be provided with 150# ANSI flanges. Basin freeboard to be minimum 18.”

2. Balancing valves: Suitable for balancing flow to each warm water basin or for balancing to obtain required distribution, and for tight shutoff at 25 psig inlet pressure. Provide balancing valves with flanged connections and position locking devices.
3. Accessories: Provide fan cylinder or casing extension for overall tower height as shown on drawings, vibration switch, and removable stainless-steel covers for hot water basins and inlet screens.

C. Sound Attenuation:

1. Materials shall be of galvanized steel and weather resistant matting or approved equal.
2. Provide corrosion resistant, factory fabricated transition section from fan outlet to attenuator base. Transition must be able to provide required clearances for piping and supports on top of tower. Refer to Drawing M-8 (attached) for pipe routing and support requirements.
3. Provide brackets and all hardware to mount to cooling tower. If mounting brackets and metal at tower support points are dissimilar, provide means to prevent galvanic action.
4. Provide instructions to contractor for assembly and rigging.
5. Cooling tower structure shall be provided from the factory able to adequately support piping, fittings, valves and sound attenuator assemblies as indicated on drawings and required within specifications without requiring field modification or steel re-enforcement by contractor.

D. Performance:

1. Design

BASE BID	
Number of Cells	2
Total Flow, gpm	900 per cell
Entering Water Temp, °F	95
Leaving Water Temp, °F	85
Design Inlet Wet Bulb, °F	73
Max pressure at inlet flange, ft	By Manufacturer
Maximum Motor HP	20.0 HP
Motor HP (Supplied)	By Manufacturer
Max. Fan tip Speed	13,000 FPM
Maximum drift (as % of scheduled flow)	.xxx %
Weight	By Manufacturer



Dimensions	By Manufacturer (Max width is 18ft – 1.5in) (Max length is 14ft –3 in)
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2. Noise: Airborne noise emitted by the cooling tower with all cells operating at full speed with any noise attenuating devices in place shall not exceed the following sound pressure levels in dBA re. 0.0002 microbar for a free and unobstructed environment. Provide A-weighted and octave band values for each for each side and top of cooling tower. Maximum values are as follows:
 - a. xx dBA at 50 ft from air inlet faces
 - b. xx dBA at 50 ft from air discharge
 - c. xx dBA at 50 ft from cased (solid) faces

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Division 16 and the following:
 1. 480 volts, three phase, 60 Hz.
- B. Motors: In accordance with Section 15065.
 1. Motors shall be TEFC (Totally-Enclosed-Fan-Cooled), NEMA T frame, NEMA F1 assembly.
- C. Disconnect Switch: Factory-mount on equipment.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify support is ready to accept tower.
- B. Verify dimensions of support are as shown on shop drawings.

3.2 INSTALLATION

- A. Install tower on steel dunnage in accordance with manufacturer's published instructions.
- B. Install tower on vibration isolators. Refer to Section 15070.
- C. Install condenser water piping with flanged connections to tower. Pitch condenser water supply to tower and condenser water suction away from tower. Refer to Section 15182.



- D. Install make-up water piping with flanged or union connections to tower. Pitch to tower. Refer to Section 15140.
- E. Install overflow, bleed, and drain, to concrete sump.
- F. Install Work in accordance with all Pennsylvania and Municipality of Shippensburg codes and standards.

3.3 FIELD QUALITY CONTROL

- A. Section 01770 - Closeout Procedures: Field inspecting, testing, adjusting, and balancing.
- B. Cleaning: Clean inside of the cooling tower thoroughly before filling with water for start-up. Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's epoxy or re-galvanizing touch-up paint approved by Department.
- C. Test for capacity under actual operating conditions per CTI Standards using an independent testing agency to verify compliance with the performance requirements. The test shall be performed on site after the tower is functional. The Department will notify the manufacturer of the date of the test. Provide supervisory personnel to witness the test.
 - 1. Should the test indicate failure to fully comply with performance requirements, modify as required and retest to demonstrate specified performance. Submit modifications for approval. Any approved modifications and retesting will be made at no cost to the Department.
- D. Sound performance compliance test: Test will be conducted by the Department's Acoustical Consultant. Test will establish compliance or non-compliance with "Sound design criteria" as specified in Performance Section. Test shall be performed on site after tower is functional. Advise Department and Professional two weeks prior to test date.
 - 1. Should test fail to meet specified performance, modify as required and retest to demonstrate specified performance. Submit modifications for approval make any modifications as approved or directed at no additional cost to the Department.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 01400 - Quality Requirements: Manufacturers' field services.
- B. Supervise rigging, hoisting, and installation; include five eight-hour days per tower.



- C. Inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturers recommendations.
- D. If alternate gear drive is used other than Marley's geared speed reducer, the first 5-years, including parts and labor, are to be provided by the cooling tower manufacturer. Frequency of oil changes are to be per the gear drive manufacturer's IOM lubrication specifications.

3.5 ADJUSTING

- A. Section 01770 - Closeout Procedures: Testing, adjusting, and balancing.
- B. Adjust bleed, control settings and airflow.

3.6 DEMONSTRATION AND TRAINING

- A. Section 01770 - Closeout Procedures: Requirements for demonstration and training.
- B. Demonstrate starting, maintenance and operation of tower.

3.7 SCHEDULES

- A. See drawings.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	04/06/2018	N/A	All	2 nd Edition – GF Edits



SECTION 15725

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for variable-air-volume, single-zone air-handling units.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 03300 - Cast-In-Place Concrete.
 - 6. Section 15065 - Motors for Mechanical Equipment.
 - 7. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 8. Section 15075 - Mechanical Identification.
 - 9. Section 15182 - Hydronic Piping.
 - 10. Section 15815 - Metal Ducts.
 - 11. Section 15820 - Duct Accessories.
 - 12. Section 15950 - Testing, Adjusting, and Balancing.
 - 13. Section 15995 - Commissioning of Mechanical Systems.
 - 14. Section 16061 - Electrical Grounding and Bonding.
 - 15. Section 16075 - Electrical Identification.
 - 16. Section 16120 - Conductors and Cables.
 - 17. Section 16123 - Control-Voltage Power Cables.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ABS: Acrylonitrile butadiene styrene.
 - 2. APD: Air pressure drop.
 - 3. BMS: Basic mapping support.
 - 4. ETL: Electrical testing laboratory.
 - 5. GFI: Ground fault interrupter.
 - 6. HDPE: High density polyethylene.
 - 7. IGBT: Insulated gate bipolar transistor,
 - 8. LAN: Local area network.
 - 9. LED: Light emitting diode.
 - 10. MPT: Male pipe thread.
 - 11. NPS: Nominal pipe size.
 - 12. NRC: Sound absorption coefficient.
 - 13. PID: Proportional-integral-derivative.



14. psig: Pounds per square inch gauge.
15. PWM: Pulse width modulation.
16. STC: Sound transmission coefficient.
17. UV: Ultraviolet.
18. VFC: Voltage frequency converter.
19. VFD: Variable frequency drive.
20. w. c.: Water column.
21. w. g.: Water gauge.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
3. dB SWL: Sound power level in decibels, and is a logarithmic measure of the sound power in comparison to a specific reference level, generally a very low base level of Watts, 10^{-12} Watts.
4. Minimum Efficiency Reporting Value (MERV): A value from 1 to 16 that along with an associated air velocity represents the efficiency of a filter, and which is based on testing using different particle sizes, 1 of 7 approved flow velocities, and the required number of repeat cycles as specified in ASHRAE 52.2.
 - a. The flow velocity used to determine a MERV value must be stated with the MERV value for the MERV number to be meaningful.
 - b. The higher the MERV number, the higher the velocity.
5. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
6. RS-485: A Telecommunications Industry Association (TIA) recommended standard for multipoint communications using two twisted-pairs defined in ANSI/TIA/EIA 485-A.

C. Reference Standards:

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - a. AHRI General OM – General Operations Manual for ARI Certification Programs.
 - b. AHRI OM-410 - Forced-Circulation Air-Cooling and Air-Heating Coils Certification Program Operational Manual.
 - c. AHRI OM-430 - Central Station Air-Handling Units Certification Program Operational Manual.



- d. AHRI OM 1060 - Air-to-Air Energy Recovery Ventilation Operations Manual.
- e. ANSI/AHRI 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
- f. ANSI/AHRI 430 – Standard for Performance Rating of Central Station Air Handling Units.
- g. ANSI/AHRI 1060 – Standard for Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation.
2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
3. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA):
 - a. ANSI/ASHRAE 33 – Methods of Testing Forced Circulation Air Cooling and Air Heating Coils.
 - b. ANSI/ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter [*withdrawn*].
 - c. ANSI/ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - d. ASHRAE 62.1-2004 – Ventilation for Acceptable Indoor Air Quality.
 - e. ASHRAE/IESNA 90.1-2004 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
4. Air Movement and Control Association, Inc. (AMCA):
 - a. AMCA 11 – Certified Ratings Program Operating Manual.
 - b. AMCA 99 – Standards Handbook.
 - c. AMCA 200 – Air Systems.
 - d. AMCA 201 – Fans and Systems.
 - e. ANSI/AMCA 210 / ANSI/ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - f. AMCA 211 - Certified Ratings Program – Product Rating Manual for Fan Air Performance.
 - g. ANSI/AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
 - h. ANSI/AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - i. AMCA 311 - Certified Ratings Program – Product Rating Manual for Fan Sound Performance.
 - j. ANSI/AMCA 500-D – Laboratory Methods of Testing Dampers for Rating.
5. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME N510 - Testing of Nuclear Air-Treatment Systems.
6. ASTM International (ASTM):



- a. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
- b. ASTM B 88M - Standard Specification for Seamless Copper Water Tube [Metric].
- c. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- d. ASTM C 423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- e. ASTM C 916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- f. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- g. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- h. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
8. CSA International (CSA):
 - a. CSA Certified Product Listings, <http://directories.csa-international.org>.
9. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
10. International Organization for Standardization (ISO):
 - a. ISO 9001 – Quality Management System – Requirements.
11. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
12. National Electrical Manufacturers Association (NEMA):
 - a. NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
 - b. NEMA MG 1 – Motors and Generators.
 - c. NEMA ICS 2 – Industrial Control and Systems Controllers, Contractors and Overload Relays Rated 600 Volts.
13. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
14. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - a. Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
15. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):



- a. ANSI/SMACNA 006 - HVAC Duct Construction Standards--Metal and Flexible.
- b. SMACNA IAQ Guidelines for Occupied Buildings Under Construction.
- 16. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA 485-A – Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
- 17. Underwriters Laboratories, Inc. (UL):
 - a. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
 - b. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.
- 18. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- 2. Coordination Drawings:
 - a. Prepare Coordination Drawings, including floor plans and other details drawn to scale, which show the following items coordinated with each other using input from the installers of the items involved:
 - 1) Mechanical-room layouts showing the relationships between the equipment components and the adjacent structural and mechanical elements.
 - a) The equipment provided must not exceed the dimensions of the unit used as the basis for design in the Contract Drawings.
 - b) Coordinate the sizes and locations of concrete bases with the actual equipment provided.
 - c) Coordinate sizes and locations of structural-steel support members, if any, with the actual equipment provided.
 - 2) The locations, types, and weights of equipment supports.
 - 3) Field measurements.
 - b. Submit the Coordination Drawings to the Program/Project Manager for approval



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Modular indoor central-station air handling units.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - c. Certificates:
 - 1) Seismic Qualification Certificates.
 - d. Delegated Design Submittals:
 - 1) Signed and sealed fabrication details and calculations.
 - e. Special Procedure Submittals:
 - 1) Construction IAQ Management Plan
 - f. Qualification Statements:
 - 1) Modular indoor central-station air handling unit manufacturer's qualifications.
 - 2) Air-to-air energy recovery heat wheel manufacturer's qualifications.
 - 3) Professional Engineer's qualifications.
 - 4) Testing Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Casing deflection test results to verify compliance with the casing deflection criteria
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's written installation and startup check instructions.
 - c. Source Quality Control Submittals:
 - 1) Fan Sound-Power Level Rating Test Quality Control Report.
 - 2) Fan Performance Rating Test Quality Control Report.
 - 3) Water Coil Test Quality Control Report.
 - 4) Sound Absorption Test Quality Control Report.
 - d. Site Quality Control Submittals:
 - 1) Field Quality-Control Report for the Leak Test.
 - 2) Field Quality-Control Report for the Fan Operational Test.
 - 3) Field Quality-Control Report for the Pre-Filter Operational Test.
 - 4) Field Quality-Control Report for the Carbon Filters Operational Test.
 - 5) Field Quality-Control Report for the Dusting and Final Filter Operational Test.



- 6) Field Quality-Control Report for the Transmission Loss Test.
- 7) Field Quality-Control Report for the Sound Absorption Test.
- e. Manufacturer's Reports:
 - 1) Manufacturer's balance report.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Hard copies and an electronic copy of the operation and maintenance data for the modular indoor central-station air handling units.
- D. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Filters:
 - (1) Furnish 1 set of filters for each modular indoor central-station air handling unit.
 - b) Pre-Filters:
 - (1) Furnish 1 spare set of pre-filters.
 - c) Dusting and Final Filters:
 - (1) Furnish one spare set of final and dusting filters.
 - d) Gaskets:
 - (1) Furnish 1 set of gaskets for each access door.
 - e) Fan Belts:
 - (1) Furnish 1 set of fan belts for each modular indoor central-station air handling unit.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky



- Harbor International Airport's agent will employ an independent Approved Agency.
- c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
1. Modular Indoor Central-Station Air Handling Unit Manufacturer's Qualifications:
 - a. Procure modular indoor central-station air handling unit equipment and air-to-air energy recovery heat wheels that have been manufactured in an ISO 9001 accredited manufacturing facility.
 - b. Submit the modular indoor central-station air handling unit manufacturer's and air-to-air energy recovery heat wheel manufacturer's qualifications to the Program/Project Manager for information.
 2. Professional Engineer's Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform vibration isolation and seismic restraint analysis required for the modular indoor central-station air handling systems.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.
 3. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the National Institute for Certification in Engineering Technologies (NICET) in accordance with the requirements specified in the Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.
- C. Certifications:
1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certification:



- a. Factory-test the modular indoor central-station air-handling units and their components in accordance with the requirements of the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Certification Program in order to have the modular indoor central-station air-handling units listed and labeled by the AHRI.
 - 1) Provide central-station air-handling units that have been tested and certified in accordance with the requirements of the AHRI Central Station Air-Handling Units Certification Program specified in AHRI General OM, AHRI OM-430, and ANSI/AHRI 430.
 - 2) Provide coils for the central-station air-handling units that have been tested and certified in accordance with the requirements of the AHRI Forced Circulation Air-Heating and Air-Cooling Coils Certification Program specified in AHRI General OM, AHRI OM-410, and ANSI/AHRI 410.
2. Air Movement and Control Association International, Inc. (AMCA)
Licensed Products:
 - a. Provide only fans licensed to bear the AMCA seals by having participated in the AMCA Certified Ratings Program for sound and air performance.
 - 1) Comply with the procedures and testing requirements for performance rating fans specified in AMCA 11, AMCA 211, and AMCA 311.
 - 2) Provide only fans labeled with the AMCA Certified Ratings Seal.
3. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
4. Listing and Labeling of Air Handling Equipment:



- a. Provide air handler equipment that is listed and labeled by CSA International (CSA), Underwriters Laboratories, Inc. (UL), or another electrical testing laboratory (ETL) as complying with their requirements applicable to complete custom air handler units.
 - 1) Provide air handler units listed as a complete unit by CSA International (CSA), a Nationally Recognized Testing Laboratory (NRTL), or an electrical testing laboratory (ETL).
 - a) Individual component listing is not acceptable.
 - 2) Provide UL-recognized energy recovery wheels bearing the UL mark.
- 5. Seismic Qualification Certificates:
 - a. Prepare Seismic Qualification Certificates certifying that the modular indoor central-station air handling units, accessories, and components will withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
 - 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
 - b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - b. Provide protective wrapping on pre-finished aluminum products.
 - c. Ship fan and drive shafts with a protective coating of lubricating oil.
 - 2. Units too large to be shipped by truck in a single piece may be shipped to site in sections.
 - 3. Deliver the modular indoor central-station air handling products to the Site on a factory base rail, and encapsulated in poly shrink wrap a minimum of 6 mils thick.
- B. Storage and Handling Requirements:
 - 1. Store and protect the modular indoor central-station air handling units in a clean dry place.
 - a. Protect the modular indoor central-station air handling units from the elements and construction traffic.



- b. Handle the modular indoor central-station air handling units carefully to avoid damage to the enclosures, components, and finish.
 2. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.

C. Packaging Waste Management:

1. Remove shipping, blocking, and bracing materials.
 - a. Remove loose packing materials from inside the modular indoor central-station air handling unit.
 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MODULAR INDOOR CENTRAL-STATION AIR HANDLING UNIT ASSEMBLIES

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed:
 - 1) Energy Labs, <https://www.energylabs.com/web2/index.html>.
 - 2) Buffalo Air Handling, <http://www.buffaloair.com>.
 - 3) Climate Craft, <http://www.climatecraft.com>.
 - 4) Governair, <http://www.governair.com>.
 - 5) Huntair, Inc., a CES Group Company, <http://www.huntair.com>.
 - 6) Scott Springfield Mfg. Inc., <http://www.scottspringfield.com/MainHome.aspx>.
 - 7) Approved equal.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - 1) Any equipment substituted for the units specified in equipment schedules or otherwise on the Contract Drawings as the basis of design for this Contract must be fully equivalent to the unit specified, including unit dimensions.
 - 2) The dimensions of substituted equipment cannot exceed the dimensions of the unit specified in any direction.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC



International Building Code (IBC) as Amended by the City of Phoenix].

- b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with requirements specified in NFPA 70.
 - 2) Provide wiring complying with the requirements specified in NFPA 70.

C. Performance:

1. Structural Performance:

- a. Provide modular indoor central-station air handling units having self-supporting casing panels capable of withstanding 133 percent of the internal static pressures indicated for the unit, without panel joints exceeding a deflection of $L/200$ where "L" is the unsupported span length within the completed casings.
- b. Unit Casings:
 - 1) At 1.5 times the operating pressure, the casing deflection must be less than or equal to $1/240$ inch.
 - a) If the unit's casings are incapable of limiting deflection to $1/240$ at 1.5 times the operating pressure, have the manufacturer provide additional internal reinforcement to comply with this deflection criteria.
 - b) To verify the casings' compliance with the deflection criteria, submit the results of a casing deflection test to the Program/Project Manager for information.
 - 2) Design the unit casing so it has a leakage rate not greater than 0.75 percent on both positive and negative pressure sections at 8 inches w. c.
- c. Base:
 - 1) The frame must comply with a deflection criterion of $1/240$ for an unsupported span.
- d. Coils:
 - 1) Provide coils that have been tested up to 315 psig, and that are suitable for operation at 250 psig.
 - 2) Do not allow the coils to function as structural components of the unit.

2. Dampers:

- a. Provide dampers having a leakage rate not exceeding 2 percent of the air quantity passing the damper when its face velocity through the damper is 2000 feet per minute (10m/s) and the pressure differential is 4 inches w. g. (1000Pa) and the measurement is taken in accordance with the method specified in ANSI/AMCA 500-D.

3. Filters:

- a. Provide commercial standard size 2" thick class 2 MERV 8 pre-filters, 12" thick class 2 MERV 13 final filters.

4. Air Purification System:



- a. Provide factory installed Global Plasma Solutions i-MOD air purification system in the unit behind the chilled water cooling coils.
 - 5. Fire-Hazard Classification:
 - a. Casing Insulation Fire and Smoke Hazard Rating:
 - 1) Provide casing insulation and accessories including sealants having a composite fire and smoke hazard rating of 25/50 when measured in accordance with the requirements specified in ASTM E 84 and UL 723.
 - 6. Seismic Performance:
 - a. Provide modular indoor central-station air handling units capable of withstanding the effects of earthquake motions determined in accordance with the procedures specified in ASCE/SEI 7.
 - 1) The phrase "capable of withstanding" is hereby defined to mean the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
- D. Design Criteria:
- 1. Provide factory-assembled modular indoor central-station air handling units having the configurations and dimensions indicated on the Contract Drawings.
 - a. Provide modular indoor central-station air handling equipment having fan wall-type technology that requires an arrangement of 4 direct driven plenum fans constructed in accordance with the Air Movement and Control Association, Inc. (AMCA) requirements in AMCA 200 and AMCA 201 for the duty specified.
 - 1) Select a fan wall system that delivers the specified airflow quantity at the specified operating total static pressure and fan/motor speed.
 - a) Provide a fan wall system consisting of multiple fan and motor "cubes" spaced in the airway tunnel to produce a uniform air flow and velocity profile across the entire airway tunnel cross section.
 - b) Each fan/motor shall have its own VFD.
 - 2) Flow Measuring System:
 - a) Provide a flow measuring system consisting of a flow measuring station having 4 static pressure taps and 4 total pressure tubes located at the throat of the fan inlet cone, and that indicates the air flow in cubic feet per minute (CFM).
 - b) Provide a flow measuring system that has no effect on fan performance.
 - b. Design the units so they can be supported by a concrete housekeeping pad.
 - c. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.



2. Provide modular indoor central-station air handling units complying with the scheduled performance for airflow rates, static pressure, and sound value.
 - a. The coil and filter face velocities scheduled are maximums, so design the air handling units not to be exceed these values.
 - b. Design the air handling units to have coil flow rates and pressure drops within 10 percent of the specified values.
3. NFPA Compliance:
 - a. Provide modular indoor central-station air handling units complying with the requirements for design, fabrication, and installation of air-handling units and components specified in NFPA 90A.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) Compliance:
 - a. Provide modular indoor central-station air handling units complying with the applicable requirements specified in Section 5 "Systems and Equipment" and Section 7 "Construction and Startup" in ASHRAE 62.1-2004.
 - b. Provide modular indoor central-station air handling units complying with the applicable requirements specified in Section 6 "Heating, Ventilating, and Air-Conditioning of ASHRAE/IESNA 90.1-2004.
5. Access Panels and Access Doors:
 - a. Provide access panels and access doors at the following locations:
 - 1) Fan Section:
 - a) Provide access doors and inspection and access panels.
 - 2) Access Section:
 - a) Provide access doors.
 - 3) Coil Section:
 - a) Provide inspection and access panels.
 - 4) Damper Section:
 - a) Provide inspection and access panels.
 - 5) Filter Section:
 - a) Provide access doors large enough to allow periodic removal and installation of filters.
 - 6) Mixing Section:
 - a) Provide access doors.
6. Vibration Isolation and Seismic Restraint Design:
 - a. Employ a qualified Professional Engineer to design vibration isolation and seismic restraints complying with the performance requirements and design criteria, including comprehensive analysis data signed and sealed by the Professional Engineer responsible for their preparation.
 - 1) Vibration Isolation Base Details:
 - a) Have the Professional Engineer detail fabrication, including anchorages and attachments to the structure and to the supported equipment.



- (1) Include adjustable motor bases, rails, and frames for equipment mounting.
- 2) Design Calculations:
 - a) Have the Professional Engineer calculate the requirements for selecting vibration isolators and seismic restraints, and for designing vibration isolation bases.
 - b. Submit the signed and sealed fabrication details and calculations to the Program/Project Manager for approval.
7. Arrange the air-handling units so there is access space around the units for service and maintenance.
8. Product Data:
 - a. For each air-handling unit indicated in the Contract Documents, obtain the manufacturer's Product Data that includes the following information:
 - 1) Unit dimensions and weights, including the center of gravity of all sections.
 - a) Include equipment drawings that show plans and elevations to scale, and the location of components.
 - b) Include setting drawings, templates, diagrams, instructions, and directions for the items to be embedded.
 - c) Indicate the clearances required for service of the equipment.
 - 2) Cabinet material, metal thickness, finishes, insulation, construction details, and accessories.
 - 3) Fans:
 - a) Certified fan-performance curves that indicate the system operating conditions.
 - b) Certified fan-sound power ratings.
 - (1) Provide equipment sound levels at the inlet, discharge, and radiated.
 - c) A static pressure summary clearly indicating the internal and external pressures for the equipment.
 - d) Fan construction and accessories.
 - (1) Furnish internal vibration isolation selections as part of the Product Data.
 - e) The manufacturer's coil selections indicating compliance with the requirements specified in ANSI/AHRI 410.
 - (1) Clearly indicate the materials of construction, fluid properties, and pressure drops.
 - f) Filter information, including the initial air pressure drop (APD), recommended final APD, dust spot efficiency, media, and frame description.
 - g) Motor ratings, electrical characteristics, and motor efficiencies.
 - h) Requirements for power supply wiring, including diagrams clearly indicating factory-installed and field-installed wiring.



- 4) Certified coil-performance ratings indicating system operating conditions.
- 5) Dampers, including housings, linkages, and operators.
- 6) Filters and their performance characteristics.

E. Materials:

1. Unit Casings:

- a. Provide unit casings for the modular indoor central-station air handling units consisting of 2-inch thick double-wall acoustic roof and wall panels.
 - 1) In all sections except fan sections, provide unit casings consisting of a 16-gauge galvanized steel exterior casing wall and a solid interior wash down liner fabricated from at least 22-gauge steel.
 - a) Within fan sections, provide perforated liner.
 - 2) Between the liner and insulation, provide an offset film liner.
 - 3) Forming:
 - a) Form the walls, roofs, and floors so they each have at least two breaks at each joint.
 - 4) Mechanically fasten the panel seams using sheet metal screws or pop rivets on 8-inch centers, and caulk the seams with clear water-resistant silicone sealant.
 - a) Provide a clean flush unit exterior by turning the wall seams inward.
 - 5) Airstream Surfaces:
 - a) For surfaces in contact with the airstream, provide surfaces complying with the requirements specified in ASHRAE 62.1-2004.

b. Base:

- 1) Provide the modular indoor central-station air handling units with a structural C-channel perimeter base having intermediate channel and angle support.
 - a) For units that exceed 24 feet in length, provide at least an 8 inch base rail.
- 2) Provide a 14-gauge aluminum tread plate floor having fully welded seams for the base.
 - a) Verify the integrity of the floor by subjecting floor welds to a dye penetrant test.
 - b) Floors that are attached with screws or adhesive sealants are unacceptable.
- 3) Insulate the base using 2-inch polyurethane foam.
- 4) Provide a base pan having an integral 1.5-inch water dam, including all floor penetrations.
- 5) Provide the base with a minimum of 4 removable welded structural lifting lugs per section.
- 6) Provide 1-1/4- inch auxiliary drains downstream of the cooling coil.
- 7) Extend connections through the unit base, and cap them.



- c. Casing Insulation and Adhesive:
 - 1) Provide 2-inch casing insulation complying with the requirements for Type II fibrous glass duct lining insulation specified in ASTM C 1071, and having a minimum density of 3 pounds per cubic foot, a minimum conductivity factor of 0.23 British thermal unit-inches per square foot per hour per degree Fahrenheit (Btu-in/hr-ft²·°F), and a minimum insulation sound absorption coefficient of 1.05.
 - 2) Using adhesive and mechanical fasteners, factory-apply the casing insulation to the internal surface of section panels downstream from, and including, the cooling-coil section.
 - a) Liner Adhesive:
 - (1) Provide liner adhesive complying with the requirements for Type I adhesive specified in ASTM C 916.
 - b) Mechanical Fasteners:
 - (1) Provide galvanized steel mechanical fasteners suitable for adhesive attachment, mechanical attachment, or welding attachment to the duct without damaging the liner and without causing leakage in the cabinet when they are applied as recommended by the manufacturer.
 - c) Coat the air-stream surface of the liner materials applied in this location with a temperature-resistant coating, or depending on service-air velocity face the air-stream surface of the liner materials applied in this location with a plain or coated fibrous mat or fabric.
- d. Inspection and Access Panels and Access Doors:
 - 1) Inspection and Access Panels:
 - a) Provide double walled access panels having a 16 gauge galvanized steel exterior panel and a 22-gauge solid interior panel.
 - b) Fasteners:
 - (1) For panel lift-out operation, provide 2 or more camlock type fasteners.
 - (2) Provide an arrangement allowing the inspection and access panels to be opened against an air-pressure differential.
 - c) Gasket:
 - (1) Provide neoprene gaskets applied around the entire perimeter of each panel frame.
 - d) Size:
 - (1) Provide inspection and access panels that are large enough to allow inspection and maintenance of the air-handling unit's internal components.
 - 2) Access Doors:



- a) Provide double walled access doors having a 16 gauge galvanized steel exterior panel and a 22-gauge solid interior panel.
 - (1) Provide access doors having the same thickness as the wall.
 - b) Door Frames:
 - (1) Provide reinforced door frames so that the openings remain square during manufacturing and installation.
 - (2) Door frames formed from the casing wall are unacceptable.
 - c) Windows:
 - (1) In each fan and filter section access door, provide a double-glazed, wire-reinforced safety glass window at least 10 inches round, having an air space between the panes, and sealed with interior and exterior rubber seals.
 - d) Hinges and Latches:
 - (1) Provide a minimum of 2 ball-bearing hinges or stainless-steel piano hinges, and 2 wedge-lever-type latches that are operable from both inside and outside for each door.
 - (2) Arrange the doors so they can be opened against an air-pressure differential.
 - (3) In the event the unit size does not allow for in-swing doors on positive pressure compartments, provide a safety pressure relief latch.
 - e) Gaskets:
 - (1) Provide a double gasket arrangement having a neoprene "knife edge" seal and a 3/4-inch automotive bulb seal to continuously seal each access door.
 - (a) Seals requiring pop rivets or screwed attachments are unacceptable.
 - f) Door Size:
 - (1) Provide door openings that are at least 24 inches by 72 inches, height permitting.
 - g) Handles:
 - (1) Provide a minimum of 2 glass-reinforced Ultramid nylon handles for each door.
 - (2) Provide handles that are operable from either side of the door.
 - (3) Provide fan section doors having a tool operated locking device that is part of the handle.
 - (4) Each fan section door must be wide enough to allow the removal of the fan motor.
 - h) Provide a 1-1/4-inch test port at each access door.
- 3) Service Light:



- a) Provide 100 Watt vaporproof light fixtures having a switched junction box located inside adjacent to the door.
 - b) Locations:
 - (1) Provide a service light for [each section accessed by a door.
 - e. Condensate Drain Pans:
 - 1) To collect condensate from cooling coils, including coil piping connections, coil headers, and return bends, and to direct water toward drain connections, provide condensate drain pans that are fabricated from single-wall, stainless-steel sheet, are an integral part of the floor plating, and have a 2 percent slope in at least 2 planes.
 - a) Length:
 - (1) Extend drain pans downstream from the leaving face to a length complying with the length requirements specified in ASHRAE 62.1-2004.
 - b) Depth:
 - (1) Provide drain pans that are at least 2 inches (50mm) deep.
 - 2) Drain Connection:
 - a) Provide a drain connection located at the lowest point of each pan, and sized to prevent overflows.
 - b) Terminate the drain connections with a threaded nipple on both ends of the pan.
 - c) Connection Size:
 - (1) Provide at least a 1 inch (DN 25) nominal pipe size drain connection.
 - 3) For units with stacked coils, provide an intermediate drain pan to collect condensate from the top coil.
 - f. Air-Handling-Unit Mounting Frame:
 - 1) Provide welded formed galvanized-steel channel or structural channel supports, designed for low deflection, and having integral lifting lugs.
 - 2) Seismic Fabrication Requirements:
 - a) Provide mounting bases and the attachments to the air-handling unit sections, accessories, and components having reinforcement strong enough to withstand the seismic forces defined in Section 15070, Mechanical Sound, Vibration, and Seismic Control, when air-handling unit frame is anchored to the building structure.
2. Fan, Drive, and Motor Section:
- a. Fan and Drive Assemblies:
 - 1) Provide statically and dynamically balanced fan and drive assemblies designed for continuous operation at the maximum-rated fan speed and motor horsepower.



- 2) Fan and Drive Shafts:
 - a) Provide fan and drive shafts designed for continuous operation at the maximum-rated fan speed and motor horsepower, and having field-adjustable alignment.
 - (1) Provide turned, ground, and polished hot-rolled steel shafts having a keyway.
 - (2) Provide fan and drive shafts designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
- b. Plenum Fan Housings:
 - 1) Provide steel plenum fan housing frames and panels fabricated without the fan scroll and volute housing.
 - a) Provide multiple centrifugal plenum direct drive fans complying with the requirements for AMCA Arrangement 4 specified in AMCA 99, and having an aluminum wheel.
 - b) Provide at least Class II supply fans.
 - c) Provide fans tested in accordance with AMCA 211 and AMCA 311, and that comply with the requirements of the AMCA air performance and sound Certified Ratings Programs.
 - d) Provide continuously welded, die-formed airfoil type fan blades designed for maximum efficiency and quiet operation.
 - (1) Partial welding on airfoil blades is unacceptable.
 - e) Provide fan impellers that are statically and dynamically balanced, and provide complete fan assemblies that have been test balanced at operating speed prior to shipment.
 - (1) Submit the manufacturer's balance report to the Owner.
 - f) Provide fully enclosed metal belt guard s for the plenum fans.
 - g) Provide a full wheel screen and inlet screen fabricated from galvanized expanded metal.
 - h) The minimum acceptable fan sizes are the sizes scheduled in the Mechanical Equipment Schedule on the Contract Drawings.
 - 2) Manufacturers:
 - a) Energy Labs
 - b) Approved equal.
- c. Fan Shaft Bearings:
 - 1) Grease-Lubricated Bearings:
 - a) Provide self-aligning, pillow-block-type, ball or roller bearings rated for a minimum life (L-10) in excess of 200,000 hours at the maximum operating speed.
 - b) Provide an adapter mount and two-piece, cast-iron housing for the grease-lubricated bearings having grease lines
- d. Internal Vibration Isolation and Seismic Control:



- 1) Provide fans that are factory-mounted with the manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2 inches (50mm).
- 2) Seismic Fabrication Requirements:
 - a) For fan sections, internal mounting frames and attachments to fans, fan housings, motors, casings, accessories, and other fan section components having their fan-mounting frames and air-handling-unit mounting frames anchored to the building structure, provide reinforcement strong enough to withstand the seismic forces defined in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- 3) Provide fans and motors mounted on a welded structural steel epoxy coated isolation base.
 - a) Formed metal isolation bases are unacceptable.
- 4) Provide at least 4 seismically restrained isolators.
 - a) The minimum isolation efficiency acceptable is 98 percent.
- 5) For fans which will travel more than 1/4 inch when operating, provide spring thrust restraints.
 - a) Size and adjust the springs so the assembly floats at the design operating condition.
- e. Motor:
 - 1) Provide motors complying with the NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15065, Motors for Mechanical Equipment.
 - a) Provide motors tested and rated to Test Method B specified in IEEE 112 and Part 12.53 "Machine Sound (Medium Induction Motors)" in NEMA MG 1.
 - 2) Enclosure Type:
 - a) Provide totally enclosed, fan cooled enclosures.
 - 3) Provide NEMA Premium (TM) efficient motors complying with the requirements defined for Design B in NEMA MG 1, and insulated for 40 degrees Celsius ambient continuous duty conditions.
 - 4) Motor Sizes:
 - a) Provide at least the size motor indicated on the Contract Drawings.
 - (1) If the motor size is not indicated on the Contract Drawings, provide a motor large enough so the driven load will not require the motor to operate in a service factor range above 1.0.
 - 5) Motor Service Factor:
 - a) Provide motors rated for a motor service factor of 1.15.
 - 6) Mount the motors on an adjustable motor mount base.
 - a) For motors 20 horsepower and greater, provide a dual bolt slide adjustment base.



- 7) Controllers, Electrical Devices, and Wiring:
 - a) Provide controllers, electrical devices, and wiring complying with requirements for electrical devices and connections specified in other Sections.
- 8) Provide unit-mounted disconnect switches on the exterior of the unit.
- f. Variable Frequency Controllers:
 - 1) Provide dual variable frequency controllers complying with the requirements specified in NEMA ICS 2, and having an insulated gate bipolar transistor (IGBT), pulse width modulation (PWM), and a voltage frequency converter (VFC).
 - a) Provide dual variable frequency controllers that have been listed and labeled as a complete unit, and that are arranged to variable the speed for a 3-phase induction motor complying with the requirements for Design B motors specified in NEMA MG 1 by adjusting the output voltage and frequency.
 - b) For each drive, provide dual variable frequency controllers that are capable of driving the motor and horsepower configuration selected.
 - (1) For each duplex unit, provide an alternation method for normal operation to allow the selection of the primary controller under normal conditions.
 - (2) Interlock the dual primary variable frequency controllers so that, in the event of a failure of the primary controller, the load is automatically switched from the primary variable frequency controller over to the other variable frequency controller in the pair without operator input.
 - (3) Configure each unit so it can be locked out for maintenance, removal, or replacement without interrupting operation of the second unit in the pair.
 - 2) Output Rating:
 - a) Provide dual variable frequency controllers having output a 3-phase; 6 Hertz to 60 Hertz output, with the voltage proportional to the frequency throughout voltage range.
 - 3) Unit Operating Requirements:
 - a) Provide variable frequency controllers having an input AC voltage tolerance of 380 Volts to 500 Volts, plus or minus 10 percent.
 - b) Provide variable frequency controllers having an input frequency tolerance of 50/60 Hertz, plus or minus 6 percent.
 - c) Minimum Efficiency:
 - (1) Provide variable frequency controllers having a full load minimum efficiency of 96 percent at 60 Hertz.
 - d) Minimum Displacement Primary-Side Power Factor:



- (1) Provide variable frequency controllers having a minimum displacement primary-side power factor of 96 percent.
- e) Overload Capability:
 - (1) Provide variable frequency controllers having an overload capability of 1.1 times the base load current for 60 seconds, and 2.0 times the base load current for 3 seconds.
- f) Starting Torque:
 - (1) Provide variable frequency controllers having a starting torque 100 percent of the rated torque, or as indicated in the Contract Documents.
- g) Speed Regulation:
 - (1) Provide variable frequency controllers having a speed regulation of plus or minus 1 percent.
- 4) Provide an isolated control interface to allow the controller to follow the control signal over an 11:1 speed range.
- 5) Internal Adjustability Capabilities:
 - a) Minimum Speed:
 - (1) Provide variable frequency controllers having a minimum speed of 5 percent to 25 percent of the maximum revolutions per minute (rpm).
 - b) Maximum Speed:
 - (1) Provide variable frequency controllers having a maximum speed of 80 percent to 100 percent of the maximum revolutions per minute (rpm).
 - c) Acceleration:
 - (1) Provide variable frequency controllers having an acceleration within the range 2 seconds to 22 seconds.
 - d) Deceleration:
 - (1) Provide variable frequency controllers having a deceleration within the range 2 seconds to 22 seconds.
 - e) Current Limit:
 - (1) Provide variable frequency controllers having a current limit of 50 percent minimum to 110 percent maximum of the current rating.
- 6) Self-Protection and Reliability Features:
 - a) Input Transient Protection:
 - (1) Provide variable frequency controllers having input transient protection provided by means of surge suppressors.
 - b) Trips:
 - (1) Provide variable frequency controllers having undervoltage and overvoltage trips; and inverter overtemperature, overload, and overcurrent trips.



- (2) Provide variable frequency controllers having instantaneous line-to-line and line-to-ground overcurrent trips.
- c) Motor Overload Relays:
 - (1) Provide variable frequency controllers having adjustable motor overload relays capable of performance complying with the requirements for Class 20 performance specified in NEMA ICS 2.
- d) Notch Filter:
 - (1) Provide variable frequency controllers having a notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
- e) Loss-of-Phase Protection:
 - (1) Provide variable frequency controllers having loss-of-phase protection.
- f) Reverse-Phase Protection:
 - (1) Provide variable frequency controllers having reverse-phase protection.
- g) Short-Circuit Protection:
 - (1) Provide variable frequency controllers having short-circuit protection.
- h) Motor Overtemperature Fault:
 - (1) Provide variable frequency controllers having motor overtemperature fault protection.
- 7) Automatic Reset/Restart:
 - a) Provide variable frequency controllers having an automatic reset/restart function that attempts 3 restarts after a controller fault or on return of power after an interruption and before shutting down for a manual reset or fault correction.
 - b) Provide a bi-directional auto-speed search capable of starting into rotating loads spinning in either direction, and returning the motor to the set speed in the proper direction, without damage to the controller, motor, or load.
- 8) Power-Interruption Protection:
 - a) Provide variable frequency controllers having power-interruption protection that prevents the motor from re-energizing after a power interruption until the motor has stopped.
- 9) Torque Boost:
 - a) Provide variable frequency controllers having a torque boost feature that automatically varies the starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- 10) Motor Temperature Compensation at Slow Speeds:



- a) To protect self-cooled, fan-ventilated motors against high temperatures, provide variable frequency controllers that compensate for the motor temperatures at slow speeds by adjusting the current fallback based on the output frequency.
- 11) Status Lights:
 - a) Provide door-mounted light emitting diode (LED) status lights that indicate the following conditions:
 - (1) Power on.
 - (2) Run.
 - (3) Overvoltage.
 - (4) Line fault.
 - (5) Overcurrent.
 - (6) External fault.
- 12) Panel-Mounted Operator Station:
 - a) Provide variable frequency controllers having a panel-mounted operator station with start-stop and auto-manual selector switches having a manual-speed-control potentiometer and elapsed time meter.
 - b) Provide meters or digital readout devices, and a selector switch mounted flush in the controller door, that are connected so the following controller parameters will be indicated:
 - (1) Output frequency (Hertz).
 - (2) Motor speed (rpm).
 - (3) Motor status (running, stop, fault).
 - (4) Motor current (Amperes).
 - (5) Motor torque (percent).
 - (6) Fault or alarming status (code).
 - (7) Proportional-integral-derivative (PID) feedback signal (percent).
 - (8) DC-link voltage (Volts direct current).
 - (9) Set-point frequency (Hertz).
 - (10) Motor output voltage (volts).
- 13) Control Signal Interface:
 - a) Electric Input Signal Interface:
 - (1) Provide variable frequency controllers having a minimum of 2 analog inputs (0 Volts to 10 Volts or 0/4-20 milliamperes) and 6 programmable digital inputs.
 - b) Provide variable frequency controllers having remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
 - (1) 0 Volts DC to 10 Volts DC.
 - (2) 0-20 milliamperes or 4-20 milliamperes.
 - (3) Potentiometer using up/down digital inputs.
 - (4) Fixed frequencies using digital inputs.
 - (5) RS485 inputs.



- (6) Keypad display inputs from local manual operation.
- c) Provide variable frequency controllers having an output signal interface, with a minimum of 1 analog output signal (0/4-20 milliamperes), which can be programmed to accept any of the following:
 - (1) Output frequency (Hertz).
 - (2) Output current (load).
 - (3) DC-link voltage (Volts direct current).
 - (4) Motor torque (percent).
 - (5) Motor speed (rpm).
 - (6) Set-point frequency (Hertz).
- d) Provide variable frequency controllers having a remote indication interface, with a minimum of 2 dry circuit relay outputs (120 Volts AC, 1 Ampere), for remote indication of the following conditions:
 - (1) Motor running.
 - (2) Set-point speed reached.
 - (3) Fault and warning indication (overtemperature or overcurrent).
 - (4) High- speed or low-speed limits reached.
- 14) Communications:
 - a) Provide variable frequency controllers having an RS485 interface complying with the requirements specified in ANSI/TIA/EIA 485-A, and that allows a voltage frequency converter (VFC) to be used with an external system within a multidrop local area network (LAN) configuration.
 - (1) The interface must allow all parameter settings of the voltage frequency converter (VFC) to be programmed via the basic mapping support (BMS) control.
 - (a) Provide the capability for the voltage frequency converter (VFC) to retain these settings within the nonvolatile memory.
- 15) Integral Disconnecting Means:
 - a) Provide an instantaneous-trip circuit breaker with a lockable handle that complies with the requirements specified in NEMA AB 1.
- 16) Variable Frequency Controller Accessories:
 - a) Factory-install the variable frequency controller accessory devices in the controller enclosure unless otherwise indicated in the Contract Documents.
 - b) Push-Button Stations, Pilot Lights, and Selector Switches:
 - (1) Provide heavy-duty type push-button stations, pilot lights, and selector switches complying with the requirements specified in NEMA ICS 2.
 - c) Standard Displays:



- (1) Provide variable frequency controllers having the following standard displays:
 - (a) Output frequency (Hertz).
 - (b) Set-point frequency (Hertz).
 - (c) Motor current (amperes).
 - (d) DC-link voltage (Volts direct current).
 - (e) Motor torque (percent).
 - (f) Motor speed (rpm).
 - (g) Motor output voltage (Volts).
3. Coil Section:
 - a. Provide coil sections complying with the requirements specified in ANSI/AHRI 410.
 - 1) Fabricate the coil section so the coil can be removed and replaced for maintenance, and to allow in-place access for service and maintenance of the coils.
 - 2) Fully enclose the coils within the casing
 - b. Coils:
 - 1) Provide coils fabricated from tube having an outside diameter of at least 5/8 inches, tube walls at least 0.20 inch thick, and return bends of 0.25 inch.
 - a) Provide cooling coils having a stainless steel casing.
 - b) Provide heating coils having a galvanized casing.
 - 2) Mount the coils on angle racks that allow the coils to be individually removed.
 - a) Provide cooling coils fabricated from Type 304 stainless steel.
 - b) Provide heating coils fabricated from galvanized steel.
 - c. Coil Fins:
 - 1) Provide 0.0075-inch thick aluminum coil fins spaced so there are no more than 10 fins per inch.
 - d. Coil Connections:
 - 1) Provide red brass coil connections having male pipe threads.
 - 2) Extend the coil connections through the unit casing.
 - a) Provide grommet seals where the coils penetrate the casing, and completely seal off the internal sides of the coil penetrations.
 - e. Coil Drain Pans:
 - 1) Provide continuously welded 16 gauge stainless steel drain pans, double sloped for positive drainage, under all cooling coils.
 - a) Provide cooling coil drain pans that extend fully under the cooling coil header and return bends.
 - 2) For stacked coil configurations, provide intermediate drain pans fabricated from the same material as the primary drain pan, and interconnect the intermediate drain pans using 1-inch copper drain line.
 - f. Drain and Vent Connections:



- 1) Provide coils that are fully drainable.
- 2) Provide a drain and vent connection on each coil, and extend the drain and vent connection to the outside of the unit casing.
4. Air Filtration Section:
 - a. Provide an air filtration section complying with the requirements specified in NFPA 90A.
 - 1) Provide an air filtration section having a minimum arrestance in accordance with the requirements specified in ANSI/ASHRAE 52.1, and a minimum efficiency reporting value (MERV) in accordance with the requirements specified in ANSI/ASHRAE 52.2.
 - 2) Provide filter holding frames arranged to have a flat or angular orientation that allows the filters to be removed from one side or to be lifted out from the access plenum.
 - 3) Provide access doors on both sides of the unit.
 - b. Pre-Filters:
 - 1) Provide pleated, disposable pre-filters having a minimum efficiency reporting value (MERV) of 8, and having at least the efficiency and area as scheduled on the Contract Drawings.
 - a) Each filter consists of non-woven synthetic media, a support grid, and a frame.
 - b) Provide filters listed as UL Class II filters.
 - 2) Provide prefabricated galvanized rack to install the pre-filters on.
 - a) Where upstream access is available, provide filters that lift out.
 - b) Where upstream access is unavailable, provide filters that slide out.
 - c. Dusting and Final Filters:
 - 1) Provide dusting filters having a minimum efficiency reporting value (MERV) of 8 downstream from the sorbent.
 - 2) Provide final filters as scheduled on the Contract Drawings.
 - a) Provide high performance, deep pleated, totally rigid and disposable final filters having a minimum efficiency reporting value (MERV) of 13.
 - b) Provide final filters consisting of filter media of high density microfine glass fibers laminated to a non-woven synthetic backing and having a media support grid, contour stabilizers, and a galvanized enclosing frame.
 - c) Provide filters listed as UL Class II filters.
 - 3) Provide final filters installed in a factory-fabricated 16 gauge galvanized steel frame fitted with gaskets and having heavy duty positive sealing fasteners.
 - d. Filter Gage:
 - 1) Provide a filter gauge having a signal gauge for each bank of filters to indicate when the filters need to be changed out.



- 2) Flush mount the filter gauge within the casing.
 - a) Surface mounted gauges are unacceptable.
- 3) Provide a sensing probe and shut off valve for each gauge.
- 4) Manufacturers:
 - a) Dwyer Instruments, Inc., Series 2000, Magnehelic®, <http://www.dwyer-inst.com>.
 - b) Approved equal.
5. Electrical Requirements:
 - a. Wiring:
 - 1) Provide a junction box at each motor for the air handler.
 - 2) Provide wiring from the variable frequency drives (VFD) to the motors complying with the wiring requirements specified in other Sections.
 - b. Lighting:
 - 1) Provide a light within each service section.
 - a) Provide lights having vapour proof enclosures with guards.
 - b) Wire the lights to a single switch mounted 48 inches above the installed level of the equipment.
 - 2) Provide a ground fault interrupter (GFI) duplex service receptacle adjacent to the supply fan.
 - 3) Provide lights and service receptacles that remain powered when the unit disconnect is open.
 - 4) Provide a fused disconnect device for the light circuit.
 - c. Raceway:
 - 1) Provide a 1-inch conduit raceway the entire length of the unit having a junction box for the control wiring in each section.
 - 2) Clearly label the conduit for use by the temperature controls installer.
6. Dampers:
 - a. Provide dampers designed to minimize air leakage by means of overlapping seals.
 - b. Damper Frames:
 - 1) Provide damper frames constructed from extruded aluminum having at least a 12 gauge thickness.
 - c. Damper Blades:
 - 1) Provide 6-inch wide damper blades having a single unit airfoil design, and constructed from extruded aluminum having at least a 12 gauge thickness.
 - d. Pivot Rods:
 - 1) Provide extruded aluminum pivot rods having a 7/8-inch hexagon cross section, and that interlock into the blade section.
 - e. Bearings:
 - 1) Provide damper bearings designed to eliminate metal to metal contact.



- 2) Provide double seal type bearings having a Celcon inner bearing fixed to a hexagon headed aluminium pivot rod that rotates within a polycarbonate outer bearing that has been inserted into the damper frame to prevent the outer bearing from rotating.
- f. Blade Hardware and Linkage:
 - 1) Provide non-corrosive, reinforced cadmium plated steel hardware.
 - 2) Install the blade hardware and linkage within the frame so it is not exposed to the air stream.
 - 3) For multiple damper assemblies, provide jackshaft assemblies.
- g. Electronic Damper Operators:
 - 1) Provide direct-coupled type electronic damper operators designed for at least 60,000 full-stroke cycles at the rated torque.
 - 2) Damper Position Indicators:
 - a) Provide electronic damper position indicators having a visual scale indicating the percent of travel, and a 2-Volts DC to 10-Volts DC feedback signal.
 - 3) Operator Motors:
 - a) Provide operator motors complying with the requirements specified for the NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors in Section 15065, Motors for Mechanical Equipment.
 - b) Provide operator motors sized to have sufficient reserve power to provide a smooth modulating action or a two-position action.
 - c) Gear Trains:
 - (1) Provide permanent split-capacitor or shaded-pole type: gear trains that are completely oil immersed and sealed.
 - (2) Equip spring-return motors with an integral spiral-spring mechanism placed in housings designed so the mechanism can be easily removed for service or adjustment of the limit switches, auxiliary switches, or feedback potentiometer.
 - 4) Nonspring-Return Motors:
 - a) If providing nonspring-return motors for dampers larger than 25 Square feet (2.3m²), size the motor for a running torque of 150 inch-pounds-force (16.9Nm) and a breakaway torque of 300 inch-pounds-force (33.9Nm).
 - 5) Spring-Return Motors:
 - a) If providing spring-return motors for dampers larger than 25 Square feet (2.3m²), size the motor for a running and breakaway torque of 150 inch-pounds-force (16.9Nm).
 - 6) Torque Calculations:
 - a) Calculate the required running torque for the damper size as follows:
 - (1) Parallel-Blade Damper with Edge Seals:



- (a) For parallel-blade dampers having edge seals, provide 7 inch·pounds·force per square foot (86.8kg·cm/m²) of damper.
 - (2) Opposed-Blade Damper with Edge Seals:
 - (a) For opposed-blade dampers with edge seals, provide 5 inch·pounds·force per square foot (62kg·cm/m²) of damper.
 - (3) Parallel-Blade Damper without Edge Seals:
 - (a) For parallel-blade dampers without edge seals, provide 4 inch·pounds·force per square foot (49.6kg·cm/m²) of damper.
 - (4) Opposed-Blade Damper without Edge Seals:
 - (a) For opposed-blade dampers without edge seals, provide 3 inch·pounds·force per square foot (37.2kg·cm/m²) of damper.
 - b) For dampers having pressure drops of 2 inches w. g. to 3 inches w. g. (500Pa to 750Pa), or face velocities of 1000 feet per minute to 2500 feet per minute (5m/s to 13m/s), increase the running torque by 1.5 inch·pounds·force per square foot.
 - c) For dampers having pressure drops of 3 inches w. g. to 4 inches w. g. (750Pa to 1000 Pa), or face velocities of 2500 feet per minute to 3000 feet per minute (13m/s to 15m/s), increase the running torque by 2.0 inch·pounds·force per square foot.
- 7) Coupling:
 - a) Provide electronic damper operators having couplings consisting of a V-bolt and a V-shaped, toothed cradle.
 - 8) Overload Protection:
 - a) Provide electronic damper operators having electronic overload or digital rotation-sensing circuitry.
 - 9) Fail-Safe Operation:
 - a) Provide a mechanical, spring-return mechanism having an external, manual gear release on the nonspring-return actuators.
 - 10) Power Requirements:
 - a) For two-position spring return motors, provide 24-Volts AC power.
 - b) For modulating motors, provide maximum power of 10 voltamperes at 24 Volts AC or 8 Watts at 24-Volts DC.
 - 11) Proportional and Feedback Signals:
 - a) Provide electronic damper operators having a 2 Volts DC to 10 Volts DC or 4 milliamperes to 20 milliamperes proportional signal, and a 2 Volts DC to 10 Volts DC position feedback signal.
 - 12) Temperature Rating:



- a) Provide electronic damper operators having a temperature rating of 40 degrees Fahrenheit to 104 degrees Fahrenheit (5 degrees Celsius to 40 degrees Celsius).
 - 13) Run Time:
 - a) Provide electronic damper operators having a run time of 12 seconds to open, and 5 seconds to close.
- F. Assembly:
 - 1. Shop Fabrication:
 - a. Field fabrication of the units or their components is unacceptable.
 - 1) Install the specified components at the factory.
 - b. Seismic Fabrication Requirements:
 - 1) Fabricate the coil section, internal mounting frame and its attachment to the coils, and other coil section components with reinforcement that is strong enough to withstand the seismic forces defined in Section 15070, Mechanical Sound, Vibration, and Seismic Control, when the coil-mounting frame and air-handling-unit mounting frame are anchored to the building structure.
- G. Finishes:
 - 1. Provide casing finishes successfully tested in accordance with the requirements for finishes exposed to a salt spray for 500 hours specified in ASTM B 117.
 - 2. Primer Materials:
 - a. Provide a zero induction epoxy prime coat.
 - 3. Finish Materials:
 - a. Provide a non-isocynate acrylic finish coat.
 - 4. Shop Finishing Methods:
 - a. Steel and Galvanized-Steel Casings:
 - 1) Immediately after cleaning and pre-treating steel and galvanized-steel casings, apply the manufacturer's standard two-coat, baked-on enamel finish at the factory.
 - a) Finish the units in the manufacturer's standard color.
 - 2) Chemically cure the system to assure a hard, chemical resistant surface with strong color stability, UV resistance, and gloss protection.
 - 3) Provide a minimum dry finish thickness of 4 mils.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Materials specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.



- a. Before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.
2. Fan Sound-Power Level Rating Test:
 - a. Test Procedure:
 - 1) Test the fans in accordance with the requirements specified in ANSI/AMCA 300.
 - 2) Calculate the fan sound ratings in accordance with the requirements specified in ANSI/AMCA 301.
 - 3) Submit a quality control report for the Fan Sound-Power Level Rating Test to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Fans complying with the specified sound ratings criteria pass the Fan Performance Rating Test.
3. Fan Performance Rating Test:
 - a. Test Procedure:
 - 1) Factory-test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.
 - 2) Rate the fan performance in accordance with the requirements specified in ANSI/AMCA 210 / ANSI/ASHRAE 51.
 - 3) Submit a quality control report for the Fan Performance Rating Test to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Fans complying with the specified certified aerodynamic performance rating criteria pass the Fan Performance Rating Test.
4. Water Coil Test:
 - a. Test Procedure:
 - 1) Factory test the coils to 315 psig (2070kPa) performance in accordance with the requirements specified in ANSI/AHRI 410 and ANSI/ASHRAE 33.
 - 2) Submit a quality control report for the Water Coil Test to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Coils that have been tested up to 315 psig, and that are suitable for operation at 250 psig pass the Water Coil Test.
5. Sound Absorption Test:
 - a. Test Procedure:
 - 1) Test the casing panels in accordance the requirements for sound absorption specified in ASTM C 423 for the 2-inch wall construction.
 - 2) Test the casing panels in accordance the requirements for transmission loss specified in ASTM E 90 for the 2-inch wall construction.



- 3) Submit a quality control report for the Sound Absorption Test to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Casing panels having a minimum sound absorption coefficient (NRC) of 0.95 and a sound transmission coefficient (STC) of 35 or greater pass the Sound Absorption Test.
- B. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when modular indoor central-station air handling units for this Contract are being fabricated and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the modular indoor central-station air handling unit installer present, examine the areas and conditions where the modular indoor central-station air handling units will be installed for compliance with the requirements for installation tolerances and other conditions affecting the modular indoor central-station air handling unit performance.
 2. Examine the roughing-in for the steam, hydronic, and condensate drainage piping systems and electrical services to verify the actual locations of connections before installation of the modular indoor central-station air handling units.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the modular indoor central-station air handling units.
- B. Surface Preparation:
 1. Concrete Bases:
 - a. Provide flat concrete pads to support each modular indoor central-station air handling unit.
 - 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the walk-in medium-voltage substation switchgear.



- 2) Extend the base no less than 4 inches in all directions beyond the maximum dimensions of the modular indoor central-station air handling unit, unless otherwise indicated on the Contract Drawings, or unless required for seismic anchor support.
 - b. Place and secure anchorage devices.
 - 1) Design each fastener and support in accordance with the seismic-restraint requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control, to carry the load indicated by seismic requirements and according to seismic-restraint details.
 - 2) Install anchor bolts to the elevations required for proper attachment to the modular indoor central-station air handling units.
 - a) Install epoxy-coated anchor bolts that extend through the concrete base and anchor into the structural concrete floor.
 - b) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - c) Cast anchor-bolt inserts into the concrete bases.
 - c. Construct the concrete bases in accordance with the seismic-restraint requirements specified in Section 15060, Hangers and Supports.
 - 1) Install dowel rods to connect the concrete base to the concrete floor.
 - a) Unless otherwise indicated in the Contract Documents, install the dowel rods on 18 inches (450mm) apart on center around the full perimeter of concrete base.
 - 2) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.
- C. Demolition/Removal:
1. Installation Pathway:
 - a. Remove and replace building components and structures to provide a pathway for moving the modular indoor central-station air handling unit components into place.

3.03 INSTALLATION

- A. Equipment Mounting:
1. Install the modular indoor central-station air handling units on the concrete bases using elastomeric pads.
 - a. Install a galvanized-steel plate to equally distribute the weight of the air handling units over the elastomeric pad.
 - b. Secure the air handling units to the anchor bolts installed in the concrete bases.



- B. Filters:
 - 1. Install the filter-gage, static-pressure taps upstream and downstream of filters.
 - 2. Mount filter gages on the outside of the filter housing or filter plenum in an accessible position.
 - 3. Provide the filter gages on filter banks, and install them with separate static-pressure taps upstream and downstream of the filters.
- C. Condensate Drain Pans:
 - 1. Connect 1-1/4 nominal pipe size (DN 32), copper tubing complying with the requirements for Type M (Type C) tubing specified in ASTM B 88, (ASTM B 88M) to the condensate drain pans.
 - 2. Extend the condensate drain tubing to the nearest equipment or floor drain.
 - 3. Construct a deep trap at the connection to drain pan, and install cleanouts at changes in direction.
- D. Special Techniques:
 - 1. Do not operate the fan system until the proper filters, whether temporary or permanent, are in place.
 - 2. Identification:
 - a. Identify piping, ductwork, and other mechanical components in accordance with the requirements specified in Section 15075, Mechanical Identification.
 - b. Identify field-installed wiring and components and provide warning signs in accordance with the requirements specified in Section 16075, Electrical Identification.
- E. Systems Integration:
 - 1. For piping, comply with requirements specified for the appropriate types in other Sections.
 - a. Install the piping adjacent to air-handling unit so access for service and maintenance are allowed.
 - b. For piping connected to air-handling units mounted on vibration isolators, provide flexible connectors.
 - 2. Chilled-Water Piping:
 - a. Provide chilled-water piping complying with the applicable requirements in specified in Section 15182, Hydronic Piping.
 - b. Install a shutoff valve and a union or flange at each coil supply connection.
 - c. Install a balancing valve and a union or flange at each coil return connection.
 - 3. Ductwork:
 - a. Connect ducts to the air-handling units by providing flexible connections.



- b. Comply with requirements specified in Section 15815, Metal Ducts, and Section 15820, Duct Accessories.
- 4. Grounding:
 - a. Ground the modular indoor central-station air handling unit equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
- 5. Electrical Wiring:
 - a. Connect the modular indoor central-station air handling unit power wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.
 - b. Connect the modular indoor central-station air handling unit control wiring in accordance with the requirements specified in Section 16123, Control-Voltage Power Cables.

3.04 SITE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. During the period when modular indoor central-station air handling units are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of modular indoor central-station air handling units.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Testing Agency Responsibilities:
 - a. Field Quality-Control Reports:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality Control Report for each test conducted to record the following information pertaining to the test:
 - a) The modular indoor central-station air handling units included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.



- d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
 - b. Furnish test instruments that have been calibrated within the last 12 months, traceable to standards of the National Institute of Standards and Technology (NIST), and adequate for making positive observation of the test results.
 - 1) Make the calibration records available for examination upon request.
 - c. Test Labeling:
 - 1) Have the Testing Agency attach a label or tag to each tested component indicating satisfactory completion of the tests for that component.
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
- B. Site Tests and Inspections:
 - 1. Leak Test:
 - a. Test Procedure:
 - 1) After installation of the , have the Testing Agency fill the water coils with water, and test the coils and connections for leaks.
 - b. Acceptance Criteria:
 - 1) Water coils that do not leak pass the Leak Test.
 - 2. Fan Operational Test:
 - a. Test Procedure:
 - 1) After the electrical circuitry has been energized, have the Testing Agency start the units to confirm the proper motor rotation and unit operation.
 - b. Acceptance Criteria:
 - 1) Air handling units that have fans that rotate properly and operate as specified pass the Fan Operational Test.
 - 3. Pre-Filter Operational Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency operate the filters to demonstrate their compliance with the specified requirements.
 - 2) Test for leakage of unfiltered air while the system is operating.
 - b. Acceptance Criteria:
 - 1) Air handling units having filters complying with the requirements specified and that do not leak unfiltered air while the system is operating pass the Pre-Filter Operational Test.
 - 4. Dusting and Final Filter Operational Test:
 - a. Test Procedure:



- 1) Have the Testing Agency pressurize the dusting or final filter housing to a minimum of 3 inches w. g. (750Pa), or to the designed operating pressure, whichever is higher; and test the housing joints, door seals, and sealing edges of filter for air leaks in accordance with the pressure-decay method specified in ANSI/ASME N510.
 - b. Acceptance Criteria:
 - 1) Filter housing that do not leak air pass the Dusting and Final Filter Operational Test
5. Transmission Loss Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency test the equipment casing in accordance with the requirements for transmission loss specified in ASTM E 90.
 - b. Acceptance Criteria:
 - 1) Equipment casings complying with the scheduled sound performance pass the Transmission Loss Test.
6. Sound Absorption Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency test the equipment casing in accordance with the requirements for sound absorption specified in ASTM C 423.
 - b. Acceptance Criteria:
 - 1) Equipment casings complying with the scheduled sound performance pass the Sound Absorption Test.
7. Inspections:
 - a. Examine the casing insulation materials and filter media before installing the air-handling unit.

C. Non-Conforming Work

1. Air-handling unit or components will be considered defective if the unit or components do not pass the specified tests and inspections.
2. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

D. Manufacturer Services:

1. Engage a factory-authorized service representative to inspect, test, and adjust the modular indoor central-station air handling units' components, assemblies, and equipment installations, including connections.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork,



air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

B. Factory-Authorized Startup Service:

1. Engage a factory-authorized service representative to perform the startup activities for the Work of this Section.
2. Installation and Startup Checks:
 - a. Complete installation and startup checks in accordance with the manufacturer's written instructions.
 - 1) Submit the manufacturer's written installation and startup check instructions to the Program/Project Manager for information.
 - b. Verify that shipping, blocking, and bracing have been removed.
 - c. Verify that each modular indoor central-station air handling unit is secure on its mountings and supporting devices, and that connections to piping, ducts, and electrical systems are complete.
 - 1) Verify that the proper thermal-overload protection is installed for the motors, controllers, and switches.
 - d. Verify that the motor rotation direction is correct, fan wheels freely rotation, and bearing operation is smooth.
 - 1) Reconnect the fan drive system, align the belts, and install belt guards.
 - e. Verify that bearings, pulleys, belts, and other moving parts are lubricated with the factory-recommended lubricants.
 - f. Verify that the zone dampers for each zone open and close fully.
 - g. Verify that face-and-bypass dampers provide full face flow.
 - h. Verify that outdoor-air and return-air mixing dampers open and close, and maintain the minimum outdoor-air setting.
 - i. Comb coil fins to ensure their parallel orientation.
 - j. Verify that proper thermal-overload protection is installed for the electric coils.
 - k. Furnish and install new, clean filters.
 - l. Verify that the manual and automatic volume control dampers and the fire and smoke dampers in the connected duct systems are in the fully open position.
3. Starting Procedures:
 - a. Energize the motor; and verify the proper operation of the motor, drive system, and fan wheel.
 - 1) Adjust the fan to the indicated rpm.
 - 2) Replace fan and motor pulleys as required to achieve the design conditions.
 - b. Measure and record the motor's electrical voltage and amperage values.



- c. Manually operate the dampers from the fully closed to the fully open position, and record fan performance.
 - 1) Adjust damper linkages for proper damper operation.

3.06 ADJUSTING

- A. Test, adjust, and balance the air-handling system in accordance with the requirements specified in Section 15950, Testing, Adjusting, and Balancing.
- B. Test and adjust the controls and safeties.
 - 1. Replace damaged and malfunctioning controls and equipment.

3.07 CLEANING

- A. After completing installation and testing, adjusting, and balancing of the air-handling units and air-distribution systems, and after completing startup service; clean the air-handling units internally to remove foreign material and construction dirt and dust.
 - 1. Clean fan wheels, cabinets, dampers, coils, and filter housings; and install new, clean filters.
- A. Replace temporary filters used during construction and testing, with new, clean filters.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the air-handling units in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- A. Take steps to ensure that installed modular indoor central-station air handling units are protected during subsequent construction activities.
 - 1. Using the units for temporary purposes during construction is unacceptable.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:



1. Furnish operation and maintenance data for the split-system air-conditioning units and components for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 - a. Include instructions for lubrication, filter replacement, belt adjustment and motor maintenance; and a spare parts list and a wiring diagram.
2. Submit both hard copies and an electronic copy of the operation and maintenance data for the modular indoor central-station air handling units and components to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 15731

SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.
 - a. Units are designed for exposed or concealed mounting, and may or may not be connected to ducts.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 03100 - Concrete Forms and Accessories.
 - 7. Section 03200 - Concrete Reinforcement.
 - 8. Section 03300 - Cast-In-Place Concrete.
 - 9. Section 07720 - Roof Accessories.
 - 10. Section 15065 - Motors for Mechanical Equipment.
 - 11. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 12. Section 15815 - Metal Ducts.
 - 13. Section 15820 - Duct Accessories.
 - 14. Section 15900 - HVAC Instrumentation and Controls.
 - 15. Section 15995 - Commissioning of Mechanical Systems.
 - 16. Section 16061 - Electrical Grounding and Bonding.
 - 17. Section 16120 - Conductors and Cables.
 - 18. Section 16123 - Control-Voltage Power Cables.
 - 19. Section 16140 - Wiring Devices.
 - 20. Section 16410 - Enclosed Switches and Circuit Breakers.
 - 21. Section 16420 - Enclosed Controllers.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Air conditioning.
 - 2. CA: Commissioning Authority.
 - 3. HP: Heat pumps.
 - 4. MERV: Minimum Efficiency Reporting Value.
- B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Minimum Efficiency Reporting Value (MERV): A value from 1 to 16 that along with an associated air velocity represents the efficiency of a filter, and which is based on testing using different particle sizes, 1 of 7 approved flow velocities, and the required number of repeat cycles as specified in ASHRAE 52.2.
 - a. The flow velocity used to determine a MERV value must be stated with the MERV value for the MERV number to be meaningful.
 - b. The higher the MERV number, the higher the velocity.

C. Reference Standards:

1. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - a. AHRI 210/240 – Standard for Performance Rating of Unitary Air-Conditioning and Air Source Heat Pump Equipment.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - b. ASHRAE 62.1-2004 – Ventilation for Acceptable Indoor Air Quality.
 - c. ASHRAE/IESNA 90.1-2004 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, the Commissioning Authority, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the layout and installation of split system air conditioning units and components with other construction that penetrates roofs, walls ceilings, and floors, or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.



3. Coordinate the sizes and locations of concrete bases with the actual ground and floor mounted equipment provided.
4. Coordinate the size, location, and connection details of the actual roof, ceiling, and wall mounted equipment provided with the roof curbs, equipment supports, and roof penetrations specified in Section 07720, Roof Accessories.

B. Sequencing:

1. Provide required concrete bases and anchorage devices prior to installing the air-conditioning equipment.
2. Provide required wall, ceiling, or roof supports prior to installing the air-conditioning equipment.

C. Scheduling:

1. Schedule the installation of the split system air conditioning units so delays to other construction in the delivery path of the equipment are minimized.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Concealed Evaporator-Fan Components.
 - 2) Floor-Mounting, Evaporator-Fan Components.
 - 3) Wall-Mounting, Evaporator-Fan Components.
 - 4) Ceiling-Mounting, Evaporator-Fan Components.
 - 5) Air-Cooled, Compressor-Condenser Components.
 - 6) Water-Cooled, Compressor-Condenser Components:
 - 7) Thermostats.
 - 8) Automatic-reset timers.
 - 9) Refrigerant line kits.
 - b. Shop Drawings:
 - 1) Split-system units and related equipment.
 - 2) Setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's written installation and startup check instructions.
 - b. Site Quality Control Submittals:



- 1) Factory-authorized service representative's certified leak test reports.
 - 2) Factory-authorized service representative's certified operational test reports.
 - 3) Factory-authorized service representative's certified inspection reports.
- C. Closeout Submittals:
1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the split-system air-conditioning units and components.
 - b. Warranty Documentation:
 - 1) Split System Air Conditioning Unit Warranty.
- D. Maintenance Material Submittals:
1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Filters:
 - (1) Furnish 1 set of filters for each split system air conditioning unit.
 - b) Fan Belts:
 - (1) Furnish 1 set of fan belts for each split system air conditioning unit.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.



2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Certifications:

1. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - b. Provide protective wrapping on pre-finished aluminum products.

B. Storage and Handling Requirements:

1. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.

C. Packaging Waste Management:

1. Remove loose packing materials from inside the split system air conditioning unit components.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.



3. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Extended Correction Period:
 1. Warrant the split system air conditioning units' materials and workmanship against failures within the 5 year period after the Date of Substantial Completion:
 2. Submit the written Split System Air Conditioning Unit Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of the split-system air-conditioning units that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURED SPLIT SYSTEM AIR CONDITIONING UNITS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Carrier Air Conditioning, Div. of Carrier Corporation, www.corp.carrier.com.
 - b. First Company Products, www.firstco.com.
 - c. Friedrich Air Conditioning Company, www.friedrich.com
 - d. Koldwave, Inc., a Mestek Company, <http://www.koldwave.com>.
 - e. Lennox Industries Inc., www.lennox.com
 - f. Mitsubishi Electric, HVAC Advanced Products Division, www.mehvac.com.
 - g. Sanyo HVAC, Division of Sanyo Commercial Solutions, Sanyo Electric Company, Ltd., <http://www.sanyohvac.com>.
 - h. Tadiran Air Conditioners, Ltd.; Member of Carrier Corporation, www.tadiran-appl.com.
 - i. Trane Company (The); Unitary Products Group, www.trane.com.
 - j. York International Corp., Division of Johnson Controls, Inc., www.johnsoncontrols.com.
 - k. Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:



- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Air-Cooled and Water-Cooled Compressor-Condensers:
 - a. Minimum Energy Efficiency:
 - 1) Provide air-cooled, compressor-condenser having at least the energy efficiency specified in ASHRAE/IESNA 90.1-2007.
- D. Design Criteria:
 - 1. The Contract Drawings indicate the general arrangement of the mechanical equipment; of piping, fittings, and specialties; and of ducts.
 - a. Product Selection for Restricted Space:
 - 1) The Contract Drawings indicate the size, profiles, and dimensional requirements of split-system units based on the specific system indicated on the Contract Drawings.
 - 2) Provide split-system units, components, and accessories capable of fitting within the indicated dimensions.
 - 2. Seismic Control:
 - a. Design each fastener and support in accordance with the seismic-restraint requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control, to carry the load indicated by seismic requirements and according to seismic-restraint details.
 - 3. Product Data:
 - a. For each type of split-system unit component indicated in the Contract Documents, submit Product Data to the Program/Project Manager for approval.
 - 1) Include the rated capacities, furnished specialties, accessories, dimensions, and finishes of their products.
 - 2) Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
 - 4. Shop Drawings:
 - a. For each split-system unit and related equipment, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Include wiring diagrams of the power, signal, and control wiring.
- E. Operation:
 - 1. Operation Sequences:
 - a. Provide split system air conditioning units that follow the sequence of operation indicated on the Contract Drawings.
- F. Materials:



1. Concealed Evaporator-Fan Components:
 - a. Chassis:
 - 1) For the evaporator fans, provide galvanized steel chassis having flanged edges, removable panels for servicing, and insulation on the back of the panel.
 - 2) Insulation:
 - a) Line the duct with glass-fiber insulation facing.
 - 3) Drain Pans:
 - a) Provide insulated galvanized steel drain pans complying with the requirements specified in ASHRAE 62.1-2004, and that have a drain connection.
 - 4) Airstream Surfaces:
 - a) Provide surfaces in contact with the airstream complying with the requirements specified in ASHRAE 62.1-2004.
 - b. Refrigerant Coils:
 - 1) Provide refrigerant coils complying with the requirements specified in AHRI 210/240, fabricated from copper tube with mechanically bonded aluminum fins, and having a thermal-expansion valve.
 - c. Water Coils:
 - 1) Provide water coils fabricated from copper tubing with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5mm) apart; and having a two-position control valve.
 - a) Provide water coils leak tested underwater to 300 psig (2070kPa) without failure.
 - d. Electric Coils:
 - 1) Provide helical electric coils fabricated from nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings, an automatic-reset thermal cutout, built-in magnetic contactors, a manual-reset thermal cutout, an airflow proving device, and one-time fuses in a terminal box for overcurrent protection.
 - e. Fan:
 - 1) Provide fans consisting of a forward-curved, double-width wheel of galvanized steel directly connected to the fan motor.
 - 2) Fan Motors:
 - a) Provide multi-tapped, multispeed fan motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment, and having internal thermal protection and permanent lubrication.
 - f. Filters:
 - 1) Provide 1-inch (25mm) thick disposable filters having MERV ratings of 6 or higher, and having with fiberboard frames.
 - g. Wiring Terminations:
 - 1) Connect the motors to the chassis wiring with plug connections.
2. Wall-Mounting, Evaporator-Fan Components:



- a. Cabinet:
 - 1) Provide enameled steel cabinets of a color selected by the Program/Project Manager, and having removable panels on the front and ends and discharge drain pans with a drain connection.
 - 2) Airstream Surfaces:
 - a) Provide surfaces in contact with the airstream complying with the requirements specified in ASHRAE 62.1-2004.
 - b) Drain Pans and Drain Connection:
 - (1) Provide drain pans having a drain connection and complying with the requirements specified in ASHRAE 62.1-2004.
- b. Refrigerant Coils:
 - 1) Provide refrigerant coils complying with the requirements specified in AHRI 210/240, fabricated from copper tube with mechanically bonded aluminum fins, and having a thermal-expansion valve.
- c. Electric Coils:
 - 1) If heating is required, provide helical electric coils fabricated from nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings, an automatic-reset thermal cutout, built-in magnetic contactors, a manual-reset thermal cutout, an airflow proving device, and one-time fuses in a terminal box for overcurrent protection.
- d. Fan:
 - 1) Provide direct drive, centrifugal fans.
 - 2) Fan Motors:
 - a) Provide multi-tapped, multispeed fan motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment, and having internal thermal protection and permanent lubrication.
- e. Filters:
 - 1) Provide disposable filters having MERV ratings of 6 or higher.
- 3. Ceiling-Mounting, Evaporator-Fan Components:
 - a. Cabinet:
 - 1) Provide enameled steel cabinets of a color selected by the Program/Project Manager, and having removable panels on the front and ends and discharge drain pans with a drain connection.
 - 2) Airstream Surfaces:
 - a) Provide surfaces in contact with the airstream complying with the requirements specified in ASHRAE 62.1-2004.
 - b) Drain Pans and Drain Connection:
 - (1) Provide drain pans having a drain connection and complying with the requirements specified in ASHRAE 62.1-2007.
 - b. Refrigerant Coils:



- 1) Provide refrigerant coils complying with the requirements specified in AHRI 210/240, fabricated from copper tube with mechanically bonded aluminum fins, and having a thermal-expansion valve.
- c. Electric Coils:
 - 1) If heating is required, provide helical electric coils fabricated from nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings, an automatic-reset thermal cutout, built-in magnetic contactors, a manual-reset thermal cutout, an airflow proving device, and one-time fuses in a terminal box for overcurrent protection.
- d. Fan:
 - 1) Provide direct drive, centrifugal fans with power-induced outside air and an integral condensate pump.
 - 2) Fan Motors:
 - a) Provide multi-tapped, multispeed fan motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment, and having internal thermal protection and permanent lubrication.
- e. Filters:
 - 1) Provide disposable filters having MERV ratings of 6 or higher.
4. Air-Cooled, Compressor-Condenser Components:
 - a. Compressor-Condenser Casing:
 - 1) Provide steel compressor-condenser casings with a baked enamel finish of a color selected by the Program/Project Manager, and having removable panels for access to controls, weep holes for water drainage, and mounting holes in the base.
 - 2) Provide brass service valves, fittings, and gage ports on the exterior of the casing.
 - b. Compressor:
 - 1) Provide hermetically sealed reciprocating type compressors having crankcase heaters, and mounted on vibration isolation.
 - 2) Provide two-speed compressor motors having thermal- and current-sensitive overload devices, a start capacitor, a relay, a contactor, a manual-reset high-pressure switch, and an automatic-reset low-pressure switch.
 - 3) Refrigerant: R-407C or R-410A.
 - 4) Refrigerant: R-407C or R-410A.
 - c. Refrigerant Coils:
 - 1) Provide refrigerant coils complying with the requirements specified in AHRI 210/240, fabricated from copper tube with mechanically bonded aluminum fins, and having a liquid subcooler.
 - d. Heat Pump Components:
 - 1) For heat pump units, provide a reversing valve and low-temperature air cut-off thermostat for the heat pump.
 - e. Fan:



- 1) Provide an aluminum-propeller type fan directly connected to the fan motor.
- f. Motor:
 - 1) Provide a permanently lubricated fan motor having integral thermal-overload protection.
- g. Low Ambient Kit:
 - 1) Provide a low ambient kit permitting operation down to 45 degrees Fahrenheit (7 degrees Celsius).
- h. Mounting Base:
 - 1) Provide a polyethylene mounting base for the compressor-condenser.

2.02 ACCESSORIES

- A. Air Conditioning Controls:
 1. To control for the split system air conditioning units, provide equipment complying with the requirements specified in Section 15900, HVAC Instrumentation and Controls.
 2. Provide an air conditioning sequence of operation complying with the requirements indicated on the Contract Drawings.
- B. Thermostats:
 1. Provide a wireless infrared thermostat having the following features functioning remotely to control the compressor and evaporator fan:
 - a. Compressor time delay.
 - b. 24-hour time control of the system stop and start.
 - c. Liquid-crystal display indicating the temperature, set-point temperature, time setting, operating mode, and fan speed.
 - d. Fan-speed selection, including auto setting.
- C. Automatic-Reset Timers:
 1. Provide an automatic-reset timer to prevent rapid cycling of the compressor.
- D. Refrigerant Line Kits:
 1. Provide soft-annealed copper suction and liquid lines that have been factory cleaned, dried, pressurized, and sealed.
 - a. Provide a factory-insulated suction line with flared fittings at both ends.
 2. Flexible Duct Connectors:
 - a. Provide flexible duct connectors complying with the requirements specified in Section 15820, Duct Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:



1. Examine the elements and surfaces to receive split system air conditioning unit components for compliance with installation tolerances and other conditions affecting the performance of the Work.
2. Examine split system air conditioning unit components before installation.

B. Evaluation and Assessment:

1. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Reject split system air conditioning unit components that are damaged or rusted.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the split system air conditioning unit components.

B. Surface Preparation:

1. Concrete Bases:

- a. For ground-mounted, compressor-condensers, provide flat concrete pads to support each condenser.
 - 1) Provide 4-inch (100mm) high reinforced concrete bases with chamfered edges to support the condenser.
 - 2) Extend the base no less than 4 inches (100mm) in all directions beyond the maximum dimensions of the condenser, unless otherwise indicated on the Contract Drawings.
 - 3) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.
- b. For ground-mounted, compressor-condensers, install anchor bolts to the elevations required for proper attachment to the condensers.
 - 1) Place and secure anchorage devices.
 - a) Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded to properly locate these items.
 - b) Cast anchor-bolt inserts into the concrete bases.
 - 2) Submit the setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices to the Program/Project Manager for information.

C. Demolition / Removal:

1. Installation Pathway:



- a. Remove and replace building components and structures to provide a pathway for moving the split system air conditioning unit components into place.

3.03 INSTALLATION

- A. Install evaporator-fan components using the manufacturer's standard mounting devices securely fastened to the building structure.
 1. Install split system air conditioning units level and plumb.
- B. Provide seismic restraints as required.
 1. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25mm) in accordance with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- C. Floor-Mounting, Evaporator-Fan Components:
 1. Install ground-mounting, compressor-condenser components on a polyethylene mounting base.
 2. Lift the floor-mounting, evaporator-fan components into position on the concrete base.
 3. Temporary Lifting Provisions:
 - a. Once the floor-mounting, evaporator-fan components have been placed on the concrete base, remove temporary lifting eyes, channels, and brackets, and temporary blocking for moving parts from the evaporator-fan and components.
 4. Anchor the floor-mounting, evaporator-fan components to the concrete pad with cast in place anchor bolts.
- D. Roof-Mounting Compressor-Condenser Components:
 1. Install roof-mounting compressor-condenser components on equipment supports in accordance with the requirements specified in specified in Section 07720, Roof Accessories.
 2. Anchor units to supports with removable, cadmium-plated fasteners.
- E. Refrigerant Tubing:
 1. Install and connect pre-charged refrigerant tubing to the air conditioning component's quick-connect fittings.
 2. Install tubing so access to the unit is allowed.
- F. Systems Integration:
 1. Piping Connections:
 - a. Piping installation requirements are specified in other Sections.
 - 1) Install piping adjacent to the units so access for service and maintenance is allowed.
 - b. Water Coil Connections:



- 1) For units having hot-water coils, provide water coil connections complying with the requirements specified in Section 15182, Hydronic Piping.
 - a) Connect water coils to the supply and return coil connections with a shut off-duty valve and union or flange on the supply connection, and having a throttling-duty valve and union or flange on the return connection.
- c. Remote Water-Cooled Condenser Connections:
 - 1) For units having remote water-cooled condensers, provide water coil connections complying with the requirements specified in Section 15182, Hydronic Piping.
 - a) Connect water coils to the supply and return coil connections with a shut off-duty valve and union or flange on the supply connection, and having a throttling-duty valve and union or flange on the return connection.
2. Duct Connections:
 - a. Duct installation requirements are specified in Section 15815, Metal Ducts.
 - b. For units connected to ducts, connect supply and return ducts to the split-system air-conditioning units using flexible duct connectors.
3. Electrical Connections:
 - a. Ground the equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 - b. Install power and control wiring and switches for the split system air conditioning unit components in accordance with the requirements specified in Section 16120, Conductors and Cables, Section 16123, Control-Voltage Power Cables, Section 16140, Wiring Devices, Section 15410, Enclosed Switches and Circuit Breakers, and Section 15420, Enclosed Controllers.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when split system air conditioning units are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of split system air conditioning units.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in



- materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
- c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- 2. Leak Test:
 - a. Test Procedure:
 - 1) After the split system air conditioning units are installed, charge the system, and have a factory-authorized service representative test/assist in testing the system for leaks.
 - 2) Have the factory-authorized service representative prepare and submit certified test reports documenting the leak testing to the Program/Project Manager for information:
 - b. Acceptance Criteria:
 - 1) Split system air conditioning units whose components the factory-authorized service representative deems to show no signs of leakage pass the Leak Test.
 - 3. Operational Test:
 - a. Test Procedure:
 - 1) After electrical circuitry has been installed and energized, have a factory-authorized service representative start the split system air conditioning units, and confirm proper motor rotation and unit operation.
 - 2) Have the factory-authorized service representative prepare and submit certified test reports documenting the operational testing to the Program/Project Manager for information:
 - b. Acceptance Criteria:
 - 1) Split system air conditioning units which the factory-authorized service representative deems to be operating normally pass the Operational Test.
- B. Non-Conforming Work
 - 1. Remove malfunctioning units, replace the malfunctioning units with acceptable units, and retest the replacement units as specified herein.
 - a. Replace damaged and malfunctioning controls and equipment.
 - 2. Repair leaks, and retest the repaired units until no leaks exist.
 - C. Manufacturer Services:
 - 1. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and the equipment installation, including connections.
 - a. Have the factory-authorized service representative submit the results of the inspections, tests, and adjustments to the Program/Project Manager in writing.



2. Engage a factory-authorized service representative to inspect field-assembled components and the equipment installation, including connections, and to assist in testing.
 - a. Have the factory-authorized service representative submit the results of the inspections to the Program/Project Manager in writing.

3.05 SYSTEM STARTUP

- A. Commissioning:
 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork, air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.
- B. Factory-Authorized Startup Service:
 1. Engage a factory-authorized service representative to perform the startup activities for the Work of this Section.
 - a. Complete installation and startup checks in accordance with the manufacturer's written instructions.
 - b. Submit the manufacturer's written installation and startup check instructions to the Program/Project Manager for information.

3.06 ADJUSTING

- A. Test and adjust controls and safeties.

3.07 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Training:
 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the air-handling units in accordance with the requirements specified in Section 01770, Closeout Procedures.



3.09 PROTECTION

- A. Take steps to ensure that installed split system air conditioning units are protected during subsequent construction activities.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
1. Furnish operation and maintenance data for the split-system air-conditioning units and components for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 2. Submit the operation and maintenance data for the split-system air-conditioning units and components to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	04/05/2018	N/A	2.01.A	Corrected several web addresses.





SECTION 15763

FAN-COIL UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for fan-coil units and accessories.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.
 - 5. Section 15065 - Motors for Mechanical Equipment.
 - 6. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 7. Section 15820 - Duct Accessories.
 - 8. Section 15900 - HVAC Instrumentation and Controls.
 - 9. Section 15995 - Commissioning of Mechanical Systems.
 - 10. Section 16061 - Electrical Grounding and Bonding.
 - 11. Section 16120 - Conductors and Cables.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ADA: Americans with Disabilities Act.
 - 2. BACnet: Building automation and control networks.
 - 3. BAS: Building automation system.
 - 4. CWP: Cold working pressure.
 - 5. DDC: Direct digital control.
 - 6. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 7. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 8. MERV: Minimum efficiency reporting value.
 - 9. PTFE: Polytetrafluoroethylene.
 - 10. TFE: Tetrafluoroethylene, a synthetic fluoropolymer.
- B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
3. Minimum Efficiency Reporting Value (MERV): A value from 1 to 16 that along with an associated air velocity represents the efficiency of a filter, and which is based on testing using different particle sizes, 1 of 7 approved flow velocities, and the required number of repeat cycles as specified in ASHRAE 52.2.
 - a. The flow velocity used to determine a MERV value must be stated with the MERV value for the MERV number to be meaningful.
 - b. The higher the MERV number, the higher the velocity.

C. Reference Standards:

1. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - a. ANSI/AHRI 440 – Standard for Performance Rating of Room Fan-Coils.
2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
3. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA):
 - a. ANSI/ASHRAE 33 – Methods of Testing Forced Circulation Air Cooling and Air Heating Coils.
 - b. ANSI/ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter [*withdrawn*].
 - c. ANSI/ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - d. ASHRAE 62.1-2004 – Ventilation for Acceptable Indoor Air Quality.
 - e. ASHRAE/IESNA 90.1-2004 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. ASTM International (ASTM):
 - a. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.



- c. ASTM B 88M - Standard Specification for Seamless Copper Water Tube [Metric].
- d. ASTM C 916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- e. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- f. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- 6. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 7. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 8. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. UL 1995 – Heating and Cooling Equipment.
- 10. U. S. Government:
 - a. Department of Justice:
 - 1) 28 CFR 36 – Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - a) ADA Standards for Accessible Design.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. Coordinate the layout and installation of the fan-coil units and suspension system components with other construction that penetrates or is supported by the ceilings, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.
 - 3. Coordination Drawings:
 - a. Prepare Coordination Drawings including floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from the installers of the items involved:
 - 1) Ceiling suspension components.
 - 2) Structural members to which the fan-coil units will be attached.
 - 3) Method of attaching the hangers to the building structure.



- 4) Size and location of the initial access modules for the acoustical tile.
- 5) Items penetrating the finished ceiling, including the following:
 - a) Lighting fixtures.
 - b) Air outlets and inlets.
 - c) Speakers.
 - d) Sprinklers.
 - e) Access panels.
- b. Submit the Coordination Drawings to the Program/Project manager for approval.
4. Coordinate the sizes and locations of wall sleeves for the outdoor-air intake.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Fan-coil units.
 - 2) BAS interface equipment.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) Shop Drawings for the fan-coil units, including wiring diagrams.
 - c. Certificates:
 - 1) Seismic Qualification Certificates.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Operational Test Reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the fan-coil units and components.
 - b. Warranty Documentation:
 - 1) Special warranty specified in this Section.

D. Maintenance Material Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Fan-Coil Unit Filters:
 - (1) Furnish 2 sets of filters for each filter installed.
 - b) Fan Belts:
 - (1) Furnish 2 sets of fan belts for each fan-coil unit installed.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Certifications:

1. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.



- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Seismic Qualification Certificates:
 - a. Prepare Seismic Qualification Certificates certifying that the fan-coil units, accessories, and components will withstand the seismic forces defined in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
 - 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
 - b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - b. Provide protective wrapping on pre-finished aluminum products.
- B. Storage and Handling Requirements:
 1. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
- C. Packaging Waste Management:
 1. Remove loose packing materials from inside the fan-coil units.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



1.07 WARRANTY

A. Fan-Coil Unit Warranty:

1. Warrant the fan-coil units against defects within the 5-year period after the Date of Substantial Completion:
 - a. Submit a Fan-Coil Units Warranty on the fan-coil unit manufacturer's standard or customized form, without monetary limitation, in which the fan-coil unit manufacturer agrees to replace fan motors, condensing units, and evaporator coils that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.
 - b. Failures include, but are not limited to, the following:
 - 1) Fan motor failure.
 - 2) Evaporator coil leaks.

PART 2 PRODUCTS

2.01 FAN-COIL UNIT EQUIPMENT

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - b. Manufacturers:
 - 1) Carrier Corporation, <http://www.carrier.com>.
 - 2) Environmental Technologies, Inc., <http://www.enviro-tec.com/index.html>.
 - 3) International Environmental Corporation, <http://www.iec-okc.com>.
 - 4) McQuay International, <http://www.mcquay.com.hk/mcquay-international/>.
 - 5) Trane, <http://www.trane.com/commercial>.
 - 6) YORK International Corporation, <http://www.johnsoncontrols.com>.
 - 7) Approved equal.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].



C. Performance:

1. Capacities and Characteristics:
 - a. Provide units having the capacities, characteristics, and accessories indicated in the Mechanical Equipment Schedule on the Contract Drawings.
2. Fire-Hazard Classification:
 - a. Coil Section Insulation:
 - 1) Provide insulation and adhesive for the coil section having a combined maximum flame-spread index of 25 and smoke-developed index of 50 when measured in accordance with the method specified in ASTM E 84.
3. Seismic Performance:
 - a. Provide fan-coil units capable of withstanding the effects of earthquake motions determined in accordance with the procedures specified in ASCE/SEI 7.
 - 1) The phrase "capable of withstanding" is hereby defined to mean the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

D. Design Criteria:

1. Provide factory-packaged and factory-tested fan-coil units rated in accordance with the requirements specified in ANSI/AHRI 440, ASHRAE 33, and UL 1995.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) Compliance:
 - a. Provide fan-coil units complying with the applicable requirements specified in Section 5 "Systems and Equipment" and Section 7 "Construction and Startup" in ASHRAE 62.1-2004.
 - 1) Airstream Surfaces:
 - a) For surfaces in contact with the airstream, comply with requirements specified in ASHRAE 62.1-2004.
 - b. Provide fan-coil units complying with the applicable requirements specified in Section 6 "Heating, Ventilating, and Air-Conditioning in ASHRAE/IESNA 90.1-2004.
3. Control Devices:
 - a. Provide the control devices indicated on the Contract Drawings and specified in Section 15900, HVAC Instrumentation and Controls.
 - 1) Basic Unit Controls:
 - a) Provide the basic unit controls indicated on the Control Drawings.
 - 2) Direct Digital Control (DDC) Terminal Controller:
 - a) Provide a direct digital control (DDC) terminal controller complying with the direct digital control (DDC) control requirements indicated on the Control Drawings.
4. Electrical Connection:



- a. Provide factory-wired motors and controls designed for a single electrical connection.
 - 5. Product Data:
 - a. Obtain the fan-coil unit manufacturer's Product Data for the fan-coil units, including the rated capacities, operating characteristics, furnished specialties, and accessories of their products.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 6. Shop Drawings:
 - a. Prepare Shop Drawings for the fan-coil units that detail the equipment assemblies, and that indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1) Wiring Diagrams:
 - a) Prepare wiring diagrams showing the power, signal, and control wiring.
 - 2) Include perimeter moldings for exposed or partially exposed cabinets.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- E. Operation:
- 1. Operation Sequences:
 - a. Provide fan-coil units that follow the sequence of operation indicated on the Contract Drawings.
- F. Materials:
- 1. Coil Section Insulation:
 - a. Provide 1/2-inch (13mm) thick, coated glass fiber insulation complying with the requirements specified in ASTM C 1071, and attached with adhesive complying with the requirements specified in ASTM C 916.
 - 2. Main and Auxiliary Drain Pans:
 - a. Provide removable insulated galvanized steel drain pans having plastic liners.
 - b. Fabricate the drain pans and drain connections in accordance with the requirements specified in ASHRAE 62.1-2004.
 - 3. Chassis:
 - a. Where the chassis will be exposed to moisture, provide a galvanized steel chassis.
 - b. Provide leveling screws for floor-mounted units.
 - 4. Cabinet:
 - a. Provide steel cabinets having a baked-enamel paint finish of the color selected by Program/Project Manager from the manufacturer's standard range.
 - 1) Vertical Unit Front Panels:



- a) For vertical units, provide removable, steel front panels having an integral stamped discharge grille and channel-formed edges, cam fasteners, and insulation on the back of the panel.
 - 2) Horizontal Unit Bottom Panels:
 - a) For horizontal units, provide bottom panels with integral stamped discharge grilles fastened to the unit with cam fasteners and hinges, and attached with a safety chain.
 - b. Stack Unit Discharge and Return Grilles:
 - 1) For stack-type fan-coil units, provide an aluminum double-deflection discharge grille, and a louvered-type or panel-type return grille.
 - a) Provide grilles having a color selected by the Program/Project Manager from the manufacturer's standard colors.
 - 2) Provide return grilles that provide access to the fan-coil unit for maintenance.
 - c. For recessing the fan-coil units into ceilings or walls, provide steel recessing flanges.
- 5. Outdoor-Air Wall Box:
 - a. For fan-coil units having outdoor-air intakes, provide rain-resistant outdoor-air wall boxes fabricated from aluminum at least 0.1265 inch (3.2mm) thick, and that include a louver and box having integral eliminators and bird screens.
 - 1) Louver Configuration:
 - a) Provide horizontal, rain-resistant louvers.
 - 2) Louver Material:
 - a) Provide aluminum louvers.
 - 3) Bird Screen:
 - a) Provide 1/2-inch (13mm) mesh bird screens on the interior side of the louver.
 - 4) Decorative Grille:
 - a) Provide decorative grilles on the outside of the intake.
 - 5) Finish:
 - a) Provide a baked enamel finish of a color selected by the Program/Project Manager from the manufacturer's standard colors applied to the outdoor-air wall boxes.
- 6. Outdoor-Air Damper:
 - a. For wall-mounted, vertical, exposed units, provide outdoor-air dampers having galvanized steel blades with edge and end seals and nylon bearings.
 - b. Provide electronic, modulating actuators for the outdoor-air dampers.
- 7. Filters:
 - a. Provide filters having the thickness specified in the Fan-Coil-Unit Schedule on the Contract Drawings, an arrestance in accordance with the minimum requirements specified in ANSI/ASHRAE 52.1, and a



- minimum efficiency reporting value (MERV) in accordance with the requirements specified in ANSI/ASHRAE 52.2.
- b. Provide glass fiber treated filters with adhesive having an 80 percent arrestance and a 13 MERV rating.
- 8. Hydronic Coils:
 - a. Provide hydronic coils fabricated from copper tube having mechanically bonded aluminum fins spaced no closer together than 0.1 inch (2.5mm), and rated for a minimum working pressure of 200 psig (1378kPa) and a maximum entering-water temperature of 220 degrees Fahrenheit (104 degrees Celsius).
 - 1) Include a manual air vent and a drain valve.
- 9. Electric-Resistance Heating Coils:
 - a. Provide electric-resistance heating coils fabricated from nickel-chromium heating wire, free of expansion noise and hum.
 - b. Mount the electric-resistance heating coils in ceramic inserts in a galvanized steel housing.
 - c. For overcurrent protection, provide fuses in a terminal box.
 - d. For high-temperature protection, provide limit controls.
 - e. Terminate the heating coils elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- 10. Fan and Motor Board:
 - a. Provide removable fan and motor boards.
 - b. Fan:
 - 1) Provide forward curved, double width, centrifugal fans directly connected to the motor; and having thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - c. Motor:
 - 1) Provide permanently lubricated, multispeed; resiliently mounted motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment.
 - a) Mount the motors on motor boards
 - d. Wiring Terminations:
 - 1) Provide motors connected to the chassis wiring using plug connections.
- 11. Factory, Hydronic Piping Package:
 - a. For fan coil units having a factory installed piping package, provide hydronic piping consisting of copper tube complying with the requirements for Type L copper specified in ASTM B 88, (ASTM B 88M, Type B), wrought-copper fittings, and brazed joints.
 - 1) Label the piping to indicate the service, the inlet, and the outlet.
 - b. Provide a two-way or three-way, modulating control valve for the chilled-water coil.
 - c. Hose Kits:



- 1) Provide 24-inch (600mm) long hoses having a diameter at least equal to the fan-coil-unit connection size.
- 2) Provide hoses rated for a working pressure of at least 400 psig (2758kPa), and operating temperatures from 33 degrees Fahrenheit to 211 degrees Fahrenheit (0.5 degrees Celsius to 99 degrees Celsius).
- 3) Tag the hoses to indicate the equipment designations.
- d. Ball Valves:
 - 1) Provide two-piece, bronze body ball valves having a full-port, chrome-plated bronze ball, polytetrafluoroethylene (PTFE) or TFE seats, and a blowout-proof stem.
 - 2) Provide ball valves having a cold working pressure (CWP) rating of at least 600 psig (4140kPa).
- e. Balancing Valves:
 - 1) Provide ball type, bronze body balancing valves equipped with a memory stop to retain a set position, and having a calibrated orifice or venturi, connections for a portable differential pressure meter with integral seals, and threaded ends.
 - 2) Provide balancing valves rated for a working pressure of 125 psig (860kPa), and a maximum operating temperature of 250 degrees Fahrenheit (121 degrees Celsius).
- f. Automatic Flow-Control Valve:
 - 1) Provide automatic flow-control valves having a brass or ferrous-metal body and a removable, corrosion-resistant, tamperproof, self-cleaning piston spring that has been factory-set to maintain the indicated flow constant, within plus or minus 10 percent, over a differential pressure range of 2 psig to 80 psig (13.8kPa to 552kPa).
 - 2) Provide automatic flow-control valves rated for a working pressure of 300 psig (2070kPa) at 250 degrees Fahrenheit (121 degrees Celsius).
- g. Strainers:
 - 1) Provide Y-pattern hydronic strainers having a cast-iron body complying with the requirements for Class B castings specified in ASTM A 126, and threaded connections, a bolted cover, a perforated stainless-steel basket, and a bottom drain connection.
 - a) In the drain connection, provide a hose-end having a nominal pipe size of at least 1/2 inch (DN 15) and a full-port, ball-type blowdown valve.
 - 2) Provide strainers rated for a working pressure of 125 psig (860kPa).
- h. Unions:
 - 1) Provide wrought copper unions complying with the requirements specified in ANSI/ASME B16.22.
- i. Risers:



- 1) Provide risers consisting of copper pipe complying with the requirements for Type L copper specified in ASTM B 88, (ASTM B 88M, Type B) having a hose and ball valve for system flushing.
12. BAS Interface Equipment:
 - a. Provide interface relays to accommodate the scheduled operation.
 - b. Provide an interface relay to provide indication of fault at the central workstation.
 - c. Provide a BACnet or LonWorks interface for the central building automation system (BAS) workstation to allow the following functions to be performed, accomplished, or monitored as appropriate:
 - 1) Adjust set points.
 - 2) Fan-coil-unit start, stop, and operating status.
 - 3) Data inquiry, including outdoor-air damper position, supply- and room-air temperature.
 - 4) Occupied and unoccupied schedules.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the areas where fan-coil units will be installed to verify their compliance with the requirements for installation tolerances and other conditions affecting performance.
 2. Examine the roughing-in of piping and electrical connections to verify their actual locations before installing the fan-coil-units.
 3. Verify the locations of thermostats, humidistats, and other exposed control sensors indicated on the Contract Drawings and room details before installation.
- B. Evaluation and Assessment:
 1. Proceed installing the fan-coil units only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the fan-coil units.

3.03 INSTALLATION

- A. Install the fan-coil units in accordance with the requirements specified in NFPA 90A.
 1. Install the fan-coil units level and plumb.



- B. Suspend horizontal, suspended fan-coil units from the structure using elastomeric hangers.
 - 1. Provide vibration isolators in accordance with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- C. Install thermostats, humidistats, and other exposed control sensors and devices 48 inches (1220mm) above the finished floor in compliance with requirements for handicap installations specified in the ADA Standards for Accessible Design.
- D. Systems Integration:
 - 1. Piping Connections:
 - a. The Contract Drawings indicate the general arrangement of piping, fittings, and specialties.
 - 1) Piping installation requirements are specified in other Sections.
 - b. Specific connection requirements are as follows:
 - 1) Install piping adjacent to the machinery to allow service and maintenance.
 - 2) Connect piping to the factory hydronic piping of the fan-coil-unit package.
 - a) Install the piping package if it has been shipped loose.
 - 3) Connect the condensate drains to indirect waste.
 - a) Install a condensate trap having adequate depth to seal against the pressure of the fan.
 - b) Install cleanouts in the piping at changes of direction.
 - 2. Ductwork Connections:
 - a. Connect supply and return ducts to the fan-coil units using flexible duct connectors complying with the requirements specified in Section 15820, Duct Accessories.
 - 1) Comply with the safety requirements for duct connections specified in UL 1995.
 - 3. Electrical Connections:
 - a. Ground the fan-coil equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 - b. Connect the wiring to the fan-coil equipment in accordance with the requirements specified in Section 16120, Conductors and Cables.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when fan-coil units are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing



personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.

- 1) Periodic Special Inspections will be performed during the installation of fan-coil units.
- b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
- c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

B. Non-Conforming Work

1. Remove and replace malfunctioning units and retest as specified in this Section.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork, air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

B. Install new filters in each fan-coil unit within the 2 weeks after the date of Substantial Completion.

C. Operational Test:

1. After the electrical circuitry has been energized, start the units to confirm the proper motor rotation and unit operation.
2. Operate the electric heating elements through each stage to verify their proper operation and electrical connections.
3. Test and adjust the fan-coil unit controls and safety devices.
 - a. Replace damaged and malfunctioning controls and equipment.
4. Prepare test reports to document the operational test, and submit these Operational Test Reports to the Program/Project Manager for information.

3.06 ADJUSTING

A. Adjust initial temperature and humidity set points.



B. Occupancy Adjustments:

1. When requested within 12 months of the date of Substantial Completion, provide on-site assistance to adjust the system to suit occupied conditions.
2. Provide up to 2 visits to the Site during other-than-normal occupancy hours for this purpose.

3.07 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Training:

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the fan-coil units in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- A. Take steps to ensure that installed fan-coil units are protected during subsequent construction activities.

3.10 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the fan-coil units and components for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 - a. Include maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
2. Submit the operation and maintenance data for the fan-coil units and components to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15815

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for metal ducts for supply, return, outside, and exhaust air distribution systems in pressure classes from minus 2-inch water gauge to plus 10-inch water gauge.
 - a. Metal ducts include the following:
 - 1) Rectangular and round ducts and fittings.
 - 2) Single-wall, round spiral-seam ducts and formed fittings.
 - 3) Duct liner.
 - 4) Polyvinyl-chloride (PVC) coated metal ducts.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01810 – Commissioning.
4. Section 01732 - Cutting and Patching.
5. Section 07850 - Through Penetration Firestopping Systems.
6. Section 15820 - Duct Accessories.
7. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. PVC: Polyvinyl-chloride.
2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties.
3. VOC: Volatile organic compounds.
4. w. g.: Water gauge.

B. Definitions:

1. Volatile Organic Compounds (VOC): Generally meant to refer to organic chemical compounds having high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

C. Reference Standards:

1. ASTM International (ASTM):



- a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
- b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- c. ASTM B 209 - Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- d. ASTM C 916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- e. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- f. ASTM D 2582 - Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.
- g. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. National Fire Protection Association (NFPA):
 - a. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - b. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
5. National Air Duct Cleaners Association (NADCA):
 - a. NADCA General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems.
6. North American Insulation Manufacturers Association (NAIMA):
 - a. NAIMA AH124 - Fibrous Glass Duct Linear Standard.
7. NUSIG/Badger Industries:
 - a. National Uniform Seismic Installation Guidelines (NUSIG).
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. ANSI/SMACNA 001 - Seismic Restraint Manual: Guidelines for Mechanical Systems.
 - b. ANSI/SMACNA 006 - HVAC Duct Construction Standards--Metal and Flexible.
 - c. SMACNA 1143 - HVAC Air Duct Leakage Test Manual.
 - d. SMACNA Duct Cleanliness for New Construction Guidelines.
9. South Coast Air Quality Management District (SCAQMD):



- a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - a. Furnish 7 days advance notice of testing.
2. Coordinate the metal duct layout and installation with the layout and installation of suspended ceilings, fire- and smoke-control dampers, lighting, and similar finished work.
3. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Prepare plans for tight areas, such as mechanical rooms, drawn to scale, on which the following items are shown and coordinated with each other, based on input from the installers of the items involved:
 - a) Other systems installed in same space as ducts.
 - b) Mechanical and electrical equipment, and other miscellaneous items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and similar items.
 - 2) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Metal duct sheet metal materials.
 - 2) Metal duct reinforcement shapes and plates:
 - 3) Metal duct tie rods.
 - 4) Duct liner:



- 5) Metal duct sealant materials.
 - 6) Polyvinyl-chloride (PVC) coated rectangular and round ducts.
 - b. Shop Drawings:
 - 1) Metal duct system layout and construction details.
 - 2) Coordination Drawings.
 - c. Delegated Design Submittals:
 - 1) Supporting calculations for significant changes proposed to the designed layout or configuration of the duct system.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Metal duct installation instructions.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built drawings of the metal duct system.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City



of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - b. Provide protective wrapping on pre-finished aluminum products.
- B. Storage and Handling Requirements:
 - 1. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Manufacturers:
 - 1. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. NFPA Compliance:
 - 1) Comply with the installation requirements specified in NFPA 90A and NFPA 90B.
 - b. Seismic Requirements:
 - 1) Provide hangers and braces for the metal ducts designed to withstand, without damage to the equipment, the seismic forces specified in the applicable building codes.
 - a) Comply with the requirements specified in ANSI/SMACNA 001 or NUSIG.
- C. Performance:
 - 1. Duct Static-Pressure Classes:



- a. Unless otherwise indicated in the Contract Documents, construct the metal ducts according to the following static-pressure classes:
 - 1) Supply Ducts (after Air Terminal Units): 2 inches w. g.
 - 2) Return Ducts (Negative Pressure): 2 inches w. g.
 - 3) Exhaust Ducts (Negative Pressure): 2 inches w. g.
- D. Design Criteria:
 - 1. Design Standard:
 - a. For acceptable materials, material thicknesses, and duct construction methods, comply with the requirements specified in ANSI/SMACNA 006, unless otherwise indicated.
 - b. Product Data:
 - 1) Submit Product Data and the manufacturer's installation instructions for the products proposed for the Work of this Section, including the manufacturer's product specifications, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
 - 2. Duct System Design:
 - a. The duct system design indicated in the Contract Documents has preselected the type and size of air-moving and air-distribution equipment and of other air system components.
 - 1) The Contract Drawings indicate the size, profiles, and dimensional requirements of metal ducts, which are based on the HVAC system requirements.
 - 2) Significant changes proposed to the designed layout or configuration of the duct system must be submitted to and specifically approved in writing by the Program/Project Manager prior to beginning the installation of the revised components.
 - a) Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing system total pressure.
 - b. Shop Drawings:
 - 1) Submit Shop Drawings of the metal duct system showing the system layout and construction details to the Program/Project Manager for approval prior to fabrication.
 - 2) Significant changes proposed to the designed layout or configuration of the duct system must be submitted to and specifically approved in writing by the Program/Project Manager prior to beginning the installation of the revised components.
 - a) Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing system total pressure.



E. Materials:

1. Metal Duct Sheet Metal Materials:

- a. Provide sheet metal materials free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- b. Galvanized Sheet Steel:
 - 1) Provide lock-forming quality galvanized sheet steel complying with the requirements specified in ASTM A 653/A 653M for sheets having a G60 coating.
 - 2) For surfaces exposed to view, provide ducts having a mill-phosphatized finish.
 - 3) For underground installation, provide polyvinyl-chloride (PVC) coated rectangular and round ducts.
- c. Aluminum Sheets:
 - 1) Provide aluminum sheets complying with the requirements specified for Alloy 3003, temper H14 sheets in ASTM B 209.
 - a) For concealed ducts, provide aluminum sheets having a mill finish.
 - b) For exposed ducts, provide aluminum sheets having a standard, 1-side bright finish.

2. Metal Duct Reinforcement Shapes and Plates:

- a. Where reinforcement shapes and plates are installed on galvanized sheet metal ducts, provide galvanized-steel reinforcement.

3. Metal Duct Tie Rods:

- a. Provide galvanized steel tie rods having the following minimum diameters:
 - 1) For lengths 36 inches or less: 1/4 inch.
 - 2) For lengths longer than 36 inches: 3/8 inch.

4. Metal Duct Sealant Materials:

- a. Joint and Seam Tape:
 - 1) Provide glass-fiber-reinforced fabric joint and seam tape 2 inches wide.
- b. Tape Sealing System:
 - 1) Provide woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

F. Fabrication:

- 1. Unless otherwise indicated, construct ducts according to the requirements specified in ANSI/SMACNA 006.
 - a. Fabricate all ducts from galvanized steel.
- 2. Rectangular Duct Fabrication:



- a. Fabricate rectangular ducts, elbows, transitions, offsets, branch connections, and other construction according to ANSI/SMACNA 006, complying with the requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1) Lengths:
 - a) Fabricate rectangular ducts in lengths appropriate to the reinforcement and rigidity class required for pressure class.
 - 2) Deflection:
 - a) Do not allow duct systems to exceed the deflection limits specified in ANSI/SMACNA 006.
 - b. Cross Breaking or Cross Beading:
 - 1) Except for lined ducts, cross break or cross bead duct sides that are 19 inches and larger and 0.0359 inch thick or less with more than 10 square feet of non-braced panel area.
3. Round Duct and Fitting Fabrication:
- a. Round, Longitudinal-Seam and Spiral Lock-Seam Ducts:
 - 1) Fabricate supply ducts from galvanized steel according to the requirements specified in ANSI/SMACNA 006.
 - b. Duct Joints:
 - 1) For ducts up to 20 inches in diameter, provide interior, center-beaded slip couplings, sealed before and after fastening, and attached with sheet metal screws.
 - 2) For ducts 21 to 72 inches in diameter, provide three-piece, gasketed, flanged joints consisting of 2 internal flanges with sealant and 1 external closure band with a gasket.
 - c. 90-Degree Tees and Laterals, and Conical Tees:
 - 1) Fabricate 90-degree tees and laterals, and conical tees according to the requirements specified in ANSI/SMACNA 006, providing the metal thicknesses specified for longitudinal-seam straight ducts.
 - d. Diverging-Flow Fittings:
 - 1) Fabricate diverging-flow fittings with a reduced entrance to branch taps, and with no excess material projecting from the fitting onto the branch tap entrance.
 - e. Elbows:
 - 1) Fabricate elbows using die-formed, gored, pleated, or mitered construction.
 - a) Fabricate the bend radius of die-formed, gored, and pleated elbows 1-1/2 times the duct diameter.
 - b) For die-formed elbows up to 8 Inches in diameter and all pressures, fabricate the elbows from 0.040 inch thick material using 2-piece welded construction.



- c) For round gored elbows, fabricate the elbows from material the same thickness as for non-elbow fittings as specified herein.
- 2) Unless the elbow construction type is indicated otherwise, fabricate elbows as follows:
 - a) Round Mitered Elbows:
 - (1) For pressure classes from minus 2 inches w. g. to plus 2 inches w. g., provide welded construction and the following metal thickness:
 - (a) For Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 - (b) For Ducts 37 to 50 Inches in Diameter: 0.040 inch.
 - (2) For pressure classes from 2 inches w. g. to 10 inches w. g., provide welded construction and the following metal thicknesses:
 - (a) For Ducts 3 to 26 Inches in Diameter: 0.034 inch.
 - (b) For Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 - b) Round Elbows:
 - (1) For round elbows 8 Inches and less in diameter, fabricate the elbows only as follows:
 - (a) For 45-degree and 90-degree elbows, fabricate die-formed or pleated elbows.
 - (b) For 30-degree and 60-degree elbows fabricate pleated elbows.
 - (c) Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 - (2) For round elbows 9 through 14 Inches in diameter, fabricate the elbows only as follows:
 - (a) For 30-degree, 45-degree, 60-degree, and 90-degree elbows, fabricate gored or pleated elbows, unless space restrictions require mitered elbows.
 - (b) Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 - (3) For round elbows larger than 14 Inches in diameter, fabricate gored elbows, unless space restrictions require mitered elbows.

2.02 ACCESSORIES

A. Hangers and Supports:

- 1. Provide hangers and supports complying with the requirements specified in Section 15060, Hangers and Supports.
- 2. Building Attachments:



- a. For building attachments, provide concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for the construction materials to which the hangers are being attached.
 - 1) For standard-weight aggregate concretes or for slabs more than 4 inches thick, provide powder-actuated concrete fasteners.
 - a) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- 3. Hanger Materials:
 - a. Provide galvanized sheet steel or threaded steel rod for hangers.
 - 1) Hangers Installed in Corrosive Atmospheres:
 - a) Provide electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2) Strap and Rod Sizes:
 - a) For steel sheet width and thickness, and for steel rod diameters, provide straps and rods sized in accordance with the requirements specified in ANSI/SMACNA 006.
 - 3) For galvanized-steel straps attached to aluminum ducts, paint contact surfaces with zinc-chromate primer.
- 4. Duct Attachments:
 - a. Provide sheet metal screws, blind rivets, or self-tapping metal screws compatible with the duct materials.
- 5. Trapeze and Riser Supports:
 - a. Provide steel shapes complying with the requirements specified in ASTM A 36/A 36M.
 - 1) For galvanized-steel ducts, provide supports fabricated from galvanized-steel shapes and plates.
 - 2) For aluminum ducts, provide supports fabricated from aluminum support materials unless the materials are electrolytically separated from the ducts.
- B. Fire and Smoke Dampers:
 - 1. Provide fire and smoke dampers complying with the requirements specified in Section 15820, Duct Accessories.
- C. Firestopping Materials:
 - 1. Provide firestopping materials complying with the requirements specified in Section 07850, Through-Penetration Firestopping Systems.
- D. Flexible Connectors:



1. Provide flexible connectors complying with the requirements specified in Section 15820, Duct Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Make a thorough examination of the areas to receive the Work of this Section to verify there are ready for the installation of the metal ducts.
- B. Evaluation and Assessment:
 1. Prior to installing the metal ducts, notify the Program/Project Manager in writing of defects discovered which could affect the satisfactory completion of the Work of this Section.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the metal duct systems.
- B. Surface Preparation:
 1. Install concrete inserts for hangers and supports before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - a. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Unless otherwise indicated, install ducts according to the requirements specified in ANSI/SMACNA 006.
 1. Install round ducts in lengths not less than 12 feet, unless the duct is interrupted by fittings.
 2. Install ducts with the fewest possible joints.
 3. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to the building lines.
 - a. Avoid diagonal runs.



4. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of the building.
 5. Install ducts with a clearance of 1 inch, plus an allowance for the insulation thickness.
 6. For underground installation, provide only polyvinyl-chloride (PVC) coated metal ductwork.
- B. Fittings:
1. For changes in direction, size, and shape, and for connections, install fabricated fittings.
 2. For underground installation, provide only polyvinyl-chloride (PVC) coated metal ductwork fittings.
- C. Connections:
1. Install couplings tight to the duct wall surface, and with a minimum of projections into the duct.
 - a. Secure couplings with sheet metal screws, and provide a minimum of 3 screws in each coupling.
 - b. Install screws at intervals of 12 inches.
 2. Make connections to equipment using flexible connectors in accordance with the requirements specified in Section 15820, Duct Accessories.
 3. When making connections for branch, outlet and inlet, and terminal units, comply with the requirements specified in ANSI/SMACNA 006.
 - a. For branch ductwork connections, provide only conical duct taps.
- D. Sealing Joints and Seams:
1. Seal duct seams and joints according to the requirements specified in ANSI/SMACNA 006 for the indicated duct pressure class.
 2. Seal ducts before external insulation is applied.
 3. Before inserting connectors, apply sealant to male ends; and after inserting the connectors cover the entire joint and sheet metal screws with sealant.
- E. Hanging and Supporting Metal Ducts:
1. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
 2. Support vertical ducts at a maximum spacing of 16 feet, and at each floor.
 3. Install upper attachments to structures with an allowable load not exceeding one-fourth of the failure (proof-test) load.
- F. Finished Spaces:
1. Conceal ducts from view in finished spaces.



2. Do not encase horizontal runs in solid partitions unless this is specifically indicated in the Contract Documents.

G. Electrical Equipment Spaces:

1. Route metal ducts to avoid passing through transformer vaults and other electrical equipment spaces and enclosures.

H. Penetration of Non-Fire-Rated Partitions:

1. Where metal ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, conceal the spaces between the construction openings and the ducts or duct insulation with sheet metal flanges the same metal thickness as the metal ducts.
 - a. Overlap the openings on the 4 sides by at least 1-1/2 inches.

I. Penetration of Fire-Rated Partitions:

1. Where metal ducts pass through fire-rated interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant in accordance with the requirements specified in Section 15820, Duct Accessories, and Section 07850, Through-Penetration Firestopping Systems.

3.04 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the ductwork, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.05 RE-INSTALLATION

- A. Remove and reinstall ceiling sections to gain access to the metal ducts during the cleaning process.

3.06 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Leakage Test Procedure:

- a. Field leakage tests will be performed according to the test methods specified in SMACNA 1143.
 - 1) For round and flat-oval ducts, requirements for Leakage Class 3 will be complied with.





- 2) For rectangular ducts in pressure classes lower than and equal to 2-inch w. g. for both positive and negative pressures, requirements for Leakage Class 12 will be complied with.
 - 3) For rectangular ducts in pressure classes from 2 inches w. g. to 10 inches w. g. for both positive and negative pressures, requirements for Leakage Class 6 will be complied with.
 - b. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - c. Tests will be conducted at static pressures equal to the maximum design pressure of the system or section being tested.
 - 1) If pressure classes are not indicated, the entire system will be tested at the maximum system design pressure.
 - 2) Do not pressurize systems above the maximum design operating pressure.
 - d. Test reports will be prepared.
 2. Acceptance Criteria:
 - a. Metal ducts in compliance with the maximum allowable leakage limits specified in SMACNA 1143 for the applicable test method performed will be acceptable.
 3. Inspections:
 - a. Inspections in accordance with the requirements specified in SMACNA 1143 will be performed:
- B. Non-Conforming Work
1. Remake leaking joints, and retest the remade joints until the leakage is equal to or less than the maximum allowable.

3.07 CLEANING

- A. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within the duct systems, and remove contaminants from the building in accordance with the requirements specified in SMACNA Duct Cleanliness for New Construction.
 - a. Use vacuum-collection devices that are operated continuously during cleaning.
 - b. Connect the vacuum device to the downstream end of duct sections, so areas being cleaned are under negative pressure.
 2. Use mechanical agitation to dislodge debris adhered to the interior duct surfaces without damaging the integrity of the metal ducts, duct liner, and duct accessories.



3. Clean coils and coil drain pans according to the requirements specified in the NADCA General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems.
 - a. Keep drain pan operational during the cleaning.
 - b. Rinse coils with clean water to remove latent residues and cleaning materials, and comb and straighten fins.
- B. Mark the position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing occurs.
- C. For physical and mechanical entry into the ducts and to inspect the ducts, use the service openings as required.
 1. Create other openings complying with duct standards.
 2. Disconnect flexible ducts as required to facilitate cleaning and inspection.
- D. Vent the vacuuming system to the outside.
 1. Locate the exhaust away and downwind from air intakes and other points of entry into the building.
 2. Furnish filtration to contain debris removed from the HVAC systems.
- E. Clean the following metal duct systems by removing surface contaminants and deposits:
 1. Air outlets and inlets, including registers, grilles, and diffusers.
 2. Supply, return, and exhaust fans, including the fan housings, plenums except ceiling supply and return plenums, scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Internal surfaces of air-handling units and components, including the mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, and actuators, except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.

3.08 CLOSEOUT ACTIVITIES

- A. Record Documentation:
 1. Prepare as-built drawings of the metal duct system, including all duct accessories; and submit them to the Program/Project Manager.

3.09 PROTECTION

- A. Corrosion Protection:



1. Paint the 24 inches upstream of registers and grilles on the interiors of metal ducts that do not have duct liner.
 - a. Apply 1 coat of flat black, latex finish coat over a compatible galvanized-steel primer.
- B. Protect duct interiors from the elements and foreign materials until the building is enclosed.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15820

DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for the following duct accessories:
 - a. Backdraft dampers.
 - b. Volume dampers.
 - c. Motorized control dampers.
 - d. Combination fire and smoke dampers.
 - e. Turning vanes.
 - f. Duct-mounted access doors.
 - g. Flexible connectors.
 - h. Flexible ducts.
 - i. Duct accessory hardware.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01780 - Closeout Submittals.
4. Section 01810 - Commissioning.
5. Section 13851 - Fire Alarm.
6. Section 15065 - Motors for Mechanical Equipment.
7. Section 15075 - Mechanical Identification.
8. Section 15815 - Metal Ducts.
9. Section 15950 - Testing, Adjusting, and Balancing.
10. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. CFM: Cubic feet per minute.
2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.



4. w. g.: Water gauge.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. Air Movement and Control Association International, Inc. (AMCA):
 - a. AMCA 11 – Certified Ratings Program Operating Manual.
 - b. ANSI/AMCA 500-D – Laboratory Methods of Testing Dampers for Rating.
 - c. ANSI/AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.
 - d. AMCA 511 - Certified Ratings Program – Product Rating Manual for Air Control Devices.
2. ASTM International (ASTM):
 - a. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - b. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - c. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. ANSI/SMACNA 006 - HVAC Duct Construction Standards--Metal and Flexible.
7. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
8. Underwriters Laboratories, Inc. (UL):
 - a. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors.
 - b. UL 555 – Standard for Fire Dampers.



- c. UL 555S – Standard for Smoke Dampers.
- 9. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. Coordinate the installation of duct accessories with the installation of the ducts provided under Section 15815, Metal Ducts.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Backdraft dampers.
 - 2) Volume dampers.
 - 3) Motorized control dampers.
 - 4) Combination fire and smoke dampers.
 - 5) Turning vanes.
 - 6) Duct-mounting access doors.
 - 7) Flexible connectors.
 - 8) Flexible ducts.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Combination fire and smoke damper manufacturer's written installation instructions.



1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of the smoke control systems, smoke dampers, and fire dampers.
3. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Certifications:

1. Listing and Labeling:
 - a. Combination Fire and Smoke Dampers:
 - 1) Provide components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - a) Provide products marked with their intended use or classification.
 - b) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.



- (1) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - 2) Provide fire dampers labeled for a 1-1/2-hour rating in accordance with the requirements specified in UL 555.
 - 3) Provide smoke dampers labeled in accordance with the requirements specified in UL 555S.
2. Air Movement and Control Association International, Inc. (AMCA) Licensed Products:
 - a. Motorized Control Dampers:
 - 1) Provide only motorized control dampers that have been licensed to bear the AMCA seals by having participated in the AMCA Certified Ratings Program.
 - a) Comply with the procedures and testing requirements for performance rating fans specified in AMCA 11, AMCA 511, ANSI/AMCA 500-D, and ANSI/AMCA 500-L.
 - b) Provide only motorized control dampers labeled with the AMCA Certified Ratings Seals.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
 - b. Provide protective wrapping on pre-finished aluminum products.
- B. Storage and Handling Requirements:
 1. Store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 DUCT ACCESSORY EQUIPMENT

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.



2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

2. Sustainability Requirements:

a. Volatile Organic Compounds (VOC) Content of Interior Sealants:

- 1) Provide interior sealants and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Multipurpose Construction Adhesives: Not more than 70 grams per Liter less water.
 - b) PVC Welding: Not more than 510 grams per Liter less water.
 - c) Adhesive Primer for Plastic: Not more than 550 grams per Liter less water.
 - d) Contact Adhesive: Not more than 80 grams per Liter less water.
 - e) Special Purpose Contact Adhesive: Not more than 250 grams per Liter less water.
 - f) Sheet Applied Rubber Lining Applications: Not more than 850 grams per Liter less water.
 - g) Metal to Metal: Not more than 30 grams per Liter less water.
 - h) Plastic Foams: Not more than 50 grams per Liter less water.
 - i) Fiberglass: Not more than 90 grams per Liter less water.
 - j) Sealant Primers for Nonporous Substrates: Not more than 250 grams per Liter less water.

C. Performance:

1. Motorized Control Dampers:

a. Operating Temperature Range:

- 1) Provide motorized control dampers capable of operating within the temperature range from minus 40 degrees Fahrenheit to plus 200 degrees Fahrenheit.



b. Leakage Rating:

- 1) Provide motorized control dampers rated for a leakage of less than 10 cubic feet per minute per square foot of damper area when tested in accordance with the methods specified in ANSI/AMCA 500-D at a differential pressure of 4 inches w. g. and when the damper is being held by a torque of 50 inch-pounds-force.

D. Design Criteria:

1. Materials and Methods:

- a. Unless otherwise indicated in the Contract Documents, comply with the requirements for acceptable materials, material thicknesses, and duct construction methods specified in ANSI/SMACNA 006.
- b. Provide duct accessories fabricated from materials suited to the duct materials.
 - 1) Provide galvanized-steel accessories in galvanized-steel ducts, and aluminum accessories in aluminum ducts.

2. Combination Fire and Smoke Damper Motors:

- a. Spring-Return Damper Motors:
 - 1) Size spring-return motors for combination fire and smoke dampers to have a running torque rating of 150 inch-pounds-force, and for a breakaway torque rating of 150 inch-pounds-force.
- b. Nonspring-Return Motors:
 - 1) Size nonspring-return motors for combination fire and smoke dampers to have a running torque rating of 150 inch-pounds-force, and for a breakaway torque rating of 300 inch-pounds-force.

3. Flexible Ducts:

- a. Provide flexible ducts designed in accordance with the following design criteria:
 - 1) Pressure Rating:
 - a) Provide flexible ducts designed for applications within the 10-inch w. g. positive to 1.0-inch w. g. negative pressure range.
 - 2) Air Velocity:
 - a) Provide flexible ducts designed to accommodate maximum air velocities of 4000 feet per minute.
 - 3) Temperature Range:
 - a) Provide flexible ducts designed for applications within the minus 10 degrees Fahrenheit to plus 160 degrees Fahrenheit temperature range.

4. Product Data:



- a. Prepare Product Data for the following duct accessories including rated capacities furnished accessories for each type of product indicated:
 - 1) Backdraft dampers.
 - 2) Volume dampers.
 - 3) Motorized control dampers.
 - 4) Combination fire and smoke dampers.
 - 5) Turning vanes.
 - 6) Duct-mounting access doors.
 - 7) Flexible connectors.
 - 8) Flexible ducts.

E. Materials:

1. Galvanized Sheet Steel:
 - a. Provide lock-forming quality galvanized sheet steel complying with the requirements specified for steel having a G60 coating designation in ASTM A 653/A 653M.
 - b. For surfaces exposed to view, provide sheets having a mill-phosphatized finish.
2. Aluminum Sheets:
 - a. Provide aluminum sheets complying with the requirements specified for Alloy 3003, Temper H14 aluminum in ASTM B 209.
 - 1) For concealed ducts provide aluminum sheets having a mill finish.
 - 2) For exposed ducts, provide aluminum sheets having a standard, 1-side bright finish.
3. Reinforcement Shapes and Plates:
 - a. Where reinforcement is required for galvanized sheet metal ducts, provide galvanized-steel reinforcement.
 - b. Where reinforcement is required for aluminum and stainless-steel ducts, provide reinforcement compatible with these materials.
4. Tie Rods:
 - a. Provide galvanized steel tie rods
 - 1) For tie rod lengths 36 inches or less, provide tie rods having diameters of at least 1/4 inch.
 - 2) For tie rod lengths longer than 36 inches, provide tie rods having diameters of at least 3/8 inch

F. Product Types:

1. Backdraft Dampers:
 - a. Provide multiple-blade, parallel action gravity balanced backdraft dampers having center-pivoted blades no more than 6 inches wide and sealed edges.



- 1) Assemble the backdraft dampers' steel ball bearings and axles so the dampers perform in a rattle-free manner.
 - 2) Provide backdraft dampers having a 90-degree stop.
 - 3) Provide an adjustment device to permit setting the backdraft dampers for varying differential static pressures.
- b. Frame:
 - 1) Fabricate the backdraft damper frames and mounting flanges from 0.052-inch thick, galvanized sheet steel.
 - a) Weld the corners of the frames and mounting flanges.
- c. Blades:
 - 1) Fabricate the backdraft damper blades from 0.025-inch thick, roll-formed aluminum.
- d. Blade Seals:
 - 1) Fabricate the backdraft damper blade seals from neoprene.
- e. Blade Axles:
 - 1) Fabricate the backdraft damper blade axels from galvanized steel.
- f. Tie Bars and Brackets:
 - 1) Fabricate the backdraft damper tie bars and brackets from aluminum.
- g. Return Spring:
 - 1) Provide a return spring having an adjustable tension for the backdraft damper.
- h. Manufacturers:
 - 1) Air Balance, Inc., www.airbalance.com
 - 2) American Warming and Ventilating, www.awv.com
 - 3) CESCO Products, www.cescoproducts.com
 - 4) Duro Dyne Corp., www.durodyne.com
 - 5) Greenheck, www.greenheck.com
 - 6) Penn Ventilation Company, Inc., <https://www.pennbarry.com/>
 - 7) Approved equal.
2. Volume Dampers:
 - a. Provide factory-fabricated volume dampers suitable for horizontal or vertical applications, and having the required hardware and accessories.
 - 1) Provide multiple-blade or single-blade, parallel-blade or opposed-blade designs as indicated on the Contract Drawings.
 - 2) Stiffen the damper blades to provide stability.
 - 3) Provide a locking device to hold single-blade dampers in a fixed position without vibration.



- 4) Where damper components penetrate the duct, close the duct penetrations so the duct seal is consistent with the requirements for the pressure class of the duct.
- b. Higher Pressure Classes:
 - 1) For volume dampers intended for pressures of 3-inch w. g. or higher, provide axles extending the full length of the damper blades and having bearings at both ends of the operating shaft.
 - a) Provide end bearings or other appropriate seals for the ducts.
- c. Standard Volume Dampers:
 - 1) For volume dampers having a standard leakage rating, mount the linkage outside the airstream.
 - 2) Frames:
 - a) Fabricate frames for standard volume dampers from hat-shaped, galvanized sheet steel channels at least 0.064 inch thick, and miter and weld the frames' corners.
 - (1) For frames indicated to be attached to walls on the Contract Drawings, provide frames with flanges.
 - (2) For frames indicated to be installed in ducts, provide flangeless frames.
 - 3) Blades:
 - a) Fabricate the standard volume dampers' blades from 0.050-inch thick extruded aluminum.
 - 4) Blade Axles:
 - a) Fabricate the standard volume dampers' blade axels from galvanized steel.
 - 5) Bearings:
 - a) Fabricate the standard volume dampers' bearings from oil-impregnated bronze.
 - 6) Tie Bars and Brackets:
 - a) Fabricate the standard volume dampers' tie bars and brackets from aluminum.
- d. Low-Leakage Volume Dampers:
 - 1) For volume dampers having a low leakage rating, mount the linkage outside the airstream.
 - 2) Steel Low-Leakage Volume Dampers:
 - a) Frames:
 - (1) Fabricate the low-leakage volume damper frames from angle-shaped, galvanized sheet steel channels that are at least 0.064 inch thick.
 - (a) For frames indicated to be attached to walls on the Contract Drawings, provide frames with flanges.



- (b) For frames indicated to be installed in ducts on the Contract Drawings, provide flangeless frames.
 - (2) Miter and weld the corners of the frames and mounting flanges.
- b) Blades:
 - (1) Fabricate the low-leakage volume damper blades from 0.064 inch thick, roll-formed galvanized sheet steel.
- 3) Aluminum Low-Leakage Volume Dampers:
 - a) Frames
 - (1) Fabricate the low-leakage volume damper frames from angle-shaped, aluminum sheet channels that are at least 0.10 inch thick.
 - (a) For frames indicated to be attached to walls on the Contract Drawings, provide frames with flanges.
 - (b) For frames indicated to be installed in ducts, provide flangeless frames.
 - b) Blades:
 - (1) Fabricate the low-leakage volume damper blades from 0.050 inch thick extruded aluminum.
- 4) Blade Axles:
 - a) Fabricate the low-leakage volume dampers' blades from galvanized steel.
- 5) Bearings:
 - a) Provide either thrust or ball bearings having a stainless-steel sleeve.
- 6) Blade Seals:
 - a) Fabricate the low-leakage volume dampers' blade seals from neoprene.
- 7) Jamb Seals:
 - a) Fabricate the low-leakage volume dampers' jamb seals from cambered stainless steel.
- 8) Tie Bars and Brackets:
 - a) Fabricate the standard volume dampers' tie bars and brackets from aluminum.
- e. Multiple-Damper Jackshafts:
 - 1) Provide jackshafts consisting of a 1-inch diameter, galvanized-steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
- f. Multiple-Damper Linkage Mountings:



- 1) Provide the length and number of mountings appropriate to connect the linkage of each damper in a multiple-damper assembly.
- g. Damper Hardware:
 - 1) Provide zinc-plated hardware having a die-cast core and a 3/4-inch hexagon locking nut.
 - 2) Provide a dial and handle fabricated from 3/32-inch thick zinc-plated steel.
 - 3) Provide a center hole to suit the damper operating-rod size.
 - 4) For mounting volume dampers on insulated duct, provide elevated platforms.
- h. Manufacturers:
 - 1) Air Balance, Inc., www.airbalance.com.
 - 2) American Warming and Ventilating, www.awv.com.
 - 3) METALAIRE, Inc., www.metalaire.com.
 - 4) Nailor Industries Inc., www.nailor.com.
 - 5) Approved equal.
3. Motorized Control Dampers:
 - a. Provide opposed-blade motorized control dampers.
 - b. Frames:
 - 1) Provide motorized control damper frames fabricated from at least 0.1084-inch thick galvanized steel, and having holes for duct mounting.
 - c. Blades:
 - 1) Provide motorized control damper blades fabricated from at least 0.0635-inch thick galvanized steel, and having a maximum blade width of 8 inches.
 - 2) Provide closed-cell neoprene edging.
 - d. Blade Axles:
 - 1) Secure the motorized control damper blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware.
 - e. Bearings:
 - 1) Provide thrust bearings at each end of every motorized control damper blade.
 - f. Blade Seals:
 - 1) Provide motorized control damper blade bearings fabricated from nylon.
 - 2) Provide motorized control damper blade end seal bearings fabricated from spring-stainless-steel, against which the damper blade ends seal.
 - g. Damper Hardware:



- 1) Provide blade-linkage hardware fabricated from zinc-plated steel and brass.
- h. Manufacturers:
 - 1) Air Balance, Inc., www.airbalance.com
 - 2) American Warming and Ventilating, www.awv.com
 - 3) CESCO Products, www.cescoproducts.com
 - 4) Duro Dyne Corp., www.durodyne.com
 - 5) Greenheck, www.greenheck.com
 - 6) METALAIRES, Inc., www.metalaire.com
 - 7) Nailor Industries Inc., www.nailor.com
 - 8) Penn Ventilation Company, Inc., <https://www.pennbarry.com/>
 - 9) Approved equal.
4. Combination Fire and Smoke Dampers:
 - a. Provide combination fire and smoke dampers having replaceable fusible links rated for 165 degrees Fahrenheit.
 - b. Frame and Blades:
 - 1) Provide combination fire and smoke damper frames and blades fabricated from 0.064-inch thick galvanized sheet steel.
 - c. Mounting Sleeves:
 - 1) Provide factory-installed, 0.052-inch thick, galvanized sheet steel mounting sleeves having a length to suit the wall or floor application.
 - d. Damper Motors:
 - 1) Provide modulating damper motors complying with requirements specified in Section 15065, Motors for Mechanical Equipment, and having two-position action.
 - a) Permanent-Split-Capacitor or Shaded-Pole Motors:
 - (1) Provide permanent-split-capacitor or shaded-pole motors having oil-immersed and sealed gear trains.
 - b) Spring-Return Motors:
 - (1) Where indicated on the Contract Drawings, provide spring-return motors equipped with an integral spiral-spring mechanism.
 - (2) Enclose the entire spring mechanism in a removable housing designed for service or adjustments.
 - c) Nonspring-Return Motors:
 - (1) For dampers larger than 25 square feet, provide nonspring-return motors
 - 2) Motors in Outside-Air Intakes:
 - a) Equip motors in outside-air intakes with O-ring gaskets designed to make the motors weatherproof.



- b) Equip motors in outside-air intakes with internal heaters to permit normal operation at minus 40 degrees Fahrenheit.
 - e. Electrical Power:
 - 1) Provide combination fire and smoke damper motors designed to operate on a 115-Volt, single phase, 60 Hertz power source.
 - f. Manufacturers:
 - 1) Air Balance, Inc., www.airbalance.com.
 - 2) CESCO Products, www.cescoproducts.com.
 - 3) Greenheck, www.greenheck.com.
 - 4) Ruskin Company, www.ruskin.com.
 - 5) Approved equal.
- 5. Turning Vanes:
 - a. Provide turning vanes complying with the requirements specified in ANSI/SMACNA 006 for vanes and vane runners.
 - b. Provide vane runners that automatically align the vanes.
 - c. Manufactured Turning Vanes:
 - 1) Provide turning vanes consisting of 1-1/2-inch wide, double-vane, curved blades fabricated from galvanized sheet steel, and set 3/4 inch apart on center.
 - 2) Provide turning vanes supported by bars set 2 inches apart on center perpendicular to the blades.
 - 3) Provide turning vanes set into vane runners suitable for duct mounting.
 - d. Manufacturers:
 - 1) Ductmate Industries, Inc., www.ductmate.com.
 - 2) Duro Dyne Corp., www.durodyne.com.
 - 3) METALAIRE, Inc., www.metalaire.com.
 - 4) Approved equal.
- 6. Duct-Mounted Access Doors:
 - a. Provide duct-mounted access doors fabricated to be airtight and suitable for the duct pressure class.
 - b. Rectangular Doors:
 - 1) Provide double-wall, duct mounted rectangular doors fabricated from galvanized sheet metal and having insulation fill.
 - 2) Door Thickness:
 - a) Provide doors having the thickness indicated for duct pressure class.
 - 3) Frames:
 - a) Provide doors having a galvanized sheet steel frame having bend-over tabs and foam gaskets.
 - 4) Vision Panels:



- a) Where indicated on the Contract Drawings, provide a vision panel.
- 5) Hardware:
 - a) Provide 1-inch by 1-inch butt or piano hinges and cam style latches.
 - b) Provide the number of hinges and locks as follows:
 - (1) For doors less than 12 inches square, provide 2 sash locks to secure the door.
 - (2) For doors up to 18 inches square, provide 2 hinges and 2 sash locks.
 - (3) For doors up to 24 inches by 48 inches, provide 3 hinges and 2 compression latches.
- 6) Manufacturers:
 - a) American Warming and Ventilating, www.awv.com.
 - b) CESCO Products, www.cescoproducts.com.
 - c) Ductmate Industries, Inc., www.ductmate.com.
 - d) Greenheck, www.greenheck.com.
 - e) McGill AirFlow Corporation, www.mcgillairflow.com.
 - f) Nailor Industries Inc., www.nailor.com.
 - g) Ventfabrics, Inc., www.ventfabrics.com.
 - h) Approved equal.
- c. Round Doors:
 - 1) Provide double-wall, duct mounting round doors fabricated from galvanized sheet metal and having insulation fill.
 - 2) Door Thickness:
 - a) Provide 1-inch thick doors.
 - 3) Frames:
 - a) Provide galvanized sheet steel spin-in notched frames.
 - 4) Hardware:
 - a) Provide cam latches.
 - 5) Manufacturers:
 - a) Ductmate Industries, Inc., www.ductmate.com.
 - b) Flexmaster U.S.A., Inc., www.flexmasterusa.com.
 - c) Approved equal.
- 7. Flexible Connectors:
 - a. Provide flexible connectors fabricated from flame-retardant or noncombustible fabrics, coatings, and adhesives complying with the requirements for Class 1 materials specified in UL 181.
 - b. Flexible Connector Fabric:
 - 1) Provide glass fabric, double coated with neoprene, and weighing not less than 26 ounces per square yard.



- 2) Tensile Strength:
 - a) Provide flexible connector fabric having a minimum tensile strength of 480 pounds-force per inch in the warp direction, and 360 pounds-force per inch in the filling direction.
- 3) Service Temperature:
 - a) Provide flexible connector fabric capable of withstanding service temperatures between minus 40 degrees Fahrenheit to plus 200 degrees Fahrenheit.
- c. Manufacturers:
 - 1) Ductmate Industries, Inc., www.ductmate.com.
 - 2) Duro Dyne Corp., www.durodyne.com.
 - 3) Ventfabrics, Inc., www.ventfabrics.com.
 - 4) Approved equal.
- 8. Flexible Ducts:
 - a. Provide insulated-duct connectors consisting of 2-ply vinyl film supported by helically wound, spring-steel wire; and having fibrous-glass insulation and a polyethylene vapor barrier film.
 - b. Provide flexible ducts complying with the requirements for Class 1 ducts specified in UL 181.
 - c. Manufacturers:
 - 1) Flexmaster U.S.A., Inc., www.flexmasterusa.com.
 - 2) Hart & Cooley, Inc., www.hartandcooley.com.
 - 3) Approved equal.

2.02 ACCESSORIES

- A. Instrument Test Holes:
 - 1. Provide instrument test holes fabricated from either cast iron or cast aluminum to suit the duct material, of a length to suit the duct insulation thickness, and having a screw cap and gasket.
 - 2. Size the instrument test holes to allow insertion of a pitot tube and other testing instruments.
- B. Adhesives:
 - 1. Provide high strength, quick setting, neoprene based, waterproof, adhesives that are resistant to gasoline and grease.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:



1. Make a thorough examination of the areas to receive the Work of this Section to verify there are ready for the installation of the duct accessories.

B. Evaluation and Assessment:

1. Prior to installing the duct accessories, notify the Program/Project Manager in writing of defects discovered which could affect the satisfactory completion of the Work of this Section.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the duct accessories.

3.03 INSTALLATION

- A. Install duct accessories in accordance with the requirements specified in NFPA 90A and NFPA 90B, and according to the applicable details for metal ducts in ANSI/SMACNA 006.

B. Backdraft Dampers:

1. Install backdraft dampers on exhaust fans and exhaust ducts nearest to the outside, and where indicated in the Contract Documents.

C. Volume Dampers:

1. Install volume dampers in ducts with liner.
2. Take measures to avoid damaging the duct liner.

D. Balancing Dampers:

1. Provide balancing dampers required for air balancing at the points in the supply, return, and exhaust systems where branches lead from larger ducts.
2. Install balancing dampers at least 2 duct widths from the branch takeoff.

E. Test Holes:

1. Provide test holes at fan inlets and outlets, where required for testing and balancing purposes, and elsewhere as indicated in the Contract Documents.

F. Combination Fire and Smoke Dampers:

1. Install combination fire and smoke dampers in accordance with the manufacturer's UL-approved written instructions.



2. Submit the combination fire and smoke damper manufacturer's written installation instructions to the Program/Project Manager for information.

G. Duct Access Doors:

1. Install duct access doors to allow accessories and terminal units to be inspected, adjusted, and maintained as follows:
 - a. On both sides of duct coils.
 - b. Downstream from volume dampers and equipment.
 - c. Adjacent to combination fire and smoke dampers to provide access to reset or reinstall fusible links.
 - d. On the sides of ducts where adequate clearance is available.
2. Install rectangular, duct-mounted access doors of the following sizes for the application indicated:
 - a. One-Hand or Inspection Access: 8 inches by 5 inches.
 - b. Two-Hand Access: 12 inches by 6 inches.
 - c. Head and Hand Access: 18 inches by 10 inches.
 - d. Head and Shoulders Access: 21 inches by 14 inches.
 - e. Body Access: 25 inches by 14 inches.
 - f. Body Plus Ladder Access: 25 inches by 17 inches.
3. Label the access doors in accordance with the requirements specified in Section 15075, Mechanical Identification.

H. Flexible Connectors:

1. Install flexible connectors immediately adjacent to equipment mounted in ducts and that is associated with fans and motorized equipment supported by vibration isolators.
 - a. For fans developing static pressures of 5-inch w. g. and higher, cover the flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Flexible Ducts:

1. Connect terminal units to supply ducts directly or with lengths of flexible duct no more than 12 inches long.
2. Do not use flexible ducts to change directions.
3. Connect diffusers to low pressure ducts with lengths of flexible duct no more than 60 inches long clamped or strapped in place.
4. Connect flexible ducts to metal ducts using draw bands.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:



1. During the period when duct accessories are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Testing, Adjusting, and Balancing:
 - a. Test Procedure:
 - 1) For testing, adjusting, and balancing procedures, comply with the requirements specified in Section 15950, Testing, Adjusting, and Balancing.
 - a) Test and adjust controls and safeties.
 - b. Acceptance Criteria:
 - 1) Refer to the acceptance criteria specified in Section 15950, Testing, Adjusting, and Balancing.
 3. Inspections:
 - a. The code-required Approved Agency must perform Special Inspections of smoke control systems, including combination fire and smoke dampers and motorized control dampers provided under this Section; and of automatic shutoff systems for air distribution systems provided under Section 13851, Fire Alarm.
- B. Non-Conforming Work
1. Remove malfunctioning units, replace the malfunctioning units with acceptable units, and retest the replacement units as specified herein.
 - a. Replace damaged and malfunctioning controls and equipment.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995,



Commissioning of Mechanical Systems, for the ductwork, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.06 ADJUSTING

- A. Adjust duct accessories to ensure proper settings.
- B. Combination Fire and Smoke Dampers:
 - 1. Adjust combination fire and smoke dampers to ensure proper action.
- C. Manual-Volume Dampers:
 - 1. The final positioning of manual-volume dampers is specified in Section 15950, Testing, Adjusting, and Balancing.

3.07 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 PROTECTION

- A. Take steps to insure that installed duct accessories are protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15835

POWER VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of power ventilators:
 - a. In-line centrifugal fans.
 - b. Centrifugal roof ventilators.
 - c. Upblast propeller roof exhaust fans.
 - d. Propeller fans.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 – Commissioning.
 - 6. Section 07720 - Roof Accessories.
 - 7. Section 15065 - Motors for Mechanical Equipment.
 - 8. Section 15070 - Mechanical Sound, Vibration, and Seismic Control.
 - 9. Section 15075 - Mechanical Identification.
 - 10. Section 15060 - Hangers and Supports.
 - 11. Section 15815 - Metal Ducts.
 - 12. Section 15820 - Duct Accessories.
 - 13. Section 15950 - Testing, Adjusting, and Balancing.
 - 14. Section 15995 - Commissioning of Mechanical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. MSL: Mean sea level.
 - 2. RPM: Revolutions per minute.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. Air Movement and Control Association International, Inc. (AMCA):



- a. AMCA 11 – Certified Ratings Program Operating Manual.
- b. AMCA 99 – Standards Handbook.
- c. ANSI/AMCA 210 / ANSI/ASHRAE 51 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- d. AMCA 211 - Certified Ratings Program – Product Rating Manual for Fan Air Performance.
- e. ANSI/AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
- f. ANSI/AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- g. AMCA 311 - Certified Ratings Program – Product Rating Manual for Fan Sound Performance.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1 – Motors and Generators.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
6. Underwriters Laboratories, Inc. (UL):
 - a. UL 486A-486B – Wire Connectors.
 - b. UL 705 – Standard for Power Ventilators.
 - c. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.
7. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager, the Phoenix Sky Harbor International Airport, and others to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the installation of power ventilators with the size and location of structural-steel support members.



3. Coordinate the installation of power ventilators with the installation of roof curbs, equipment supports, and roof penetrations provided under Section 07720, Roof Accessories.

B. Sequencing:

1. Provide required anchorage devices and wall, ceiling, and roof supports prior to installing the power ventilator equipment.
2. Provide electrical power to the installed power ventilator equipment so startup and testing activities are not delayed.

C. Scheduling:

1. Schedule the installation of the power ventilator equipment so delays to other construction are minimized.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Power ventilators.
 - b. Shop Drawings:
 - 1) Power ventilators.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Power ventilator manufacturer's printed installation instructions.
 - 2) Power ventilator manufacturer's printed cleaning instructions.
 - b. Source Quality Control Submittals:
 - 1) Sound Test results.
 - 2) Fan Performance Rating Testing results.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the power ventilators.

D. Maintenance Material Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare power ventilator products that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Belts:
 - (1) Furnish an additional quantity of belts, equal to 1 set of belts for each belt-driven unit installed under this Contract, for future use as spare parts.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.



- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
 2. Air Movement and Control Association International, Inc. (AMCA) Licensed Products:
 - a. Provide only products licensed to bear the AMCA seals by having participated in the AMCA Certified Ratings Program.
 - 1) Comply with the procedures and testing requirements for performance rating fans specified in AMCA 11, AMCA 211, and AMCA 311.
 - 2) Provide only fans labeled with the AMCA Certified Ratings Seal.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver fans as factory-assembled units to the extent allowable by shipping limitations, and having protective crating and covering.
- B. Storage and Handling Requirements:
 1. Lift and support units from the manufacturer's designated lifting or supporting points.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Greenheck Fan Corporation, www.greenheck.com.



- b. JenncoFan, Division of Soler & Palau Ventilation Group, www.jencofan.com.
 - c. Loren Cook Company, www.lorencook.com.
 - d. Penn Barry, www.pennbarry.com.
 - e. Approved equal.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide electrical products and installation complying with requirements specified in NFPA 70.
- C. Performance:
 - 1. Capacities:
 - a. Provide power ventilators having the capacities and other characteristics listed in the Mechanical Equipment Schedule on the Contract Drawings.
 - 2. Air Movement and Control Association International, Inc. (AMCA) Compliance:
 - a. Provide power ventilators complying with the performance requirements for fan classification specified by the Air Movement and Control Association International, Inc. (AMCA).
 - b. Operating Limits:
 - 1) Classify power ventilators according to the requirements specified in AMCA 99 for their operating limits.
 - c. Fan Performance Ratings:
 - 1) Establish the power ventilator flow rate, pressure, power, air density, speed of rotation, and efficiency in accordance with the requirements specified in AMCA 210.
 - 2) Base air ratings on the actual Site elevation of 4400 feet above MSL.
 - d. Sound-Power Level Ratings:



- 1) Provide power ventilators having sound-power levels complying with the requirements specified in ANSI/AMCA 301.

D. Design Criteria:

1. Design Standard:

- a. Provide power ventilators complying with the requirements specified in UL 705.

2. National Electrical Manufacturers Association (NEMA) Compliance:

- a. Provide power ventilators having motors and electrical accessories complying with the requirements specified in applicable NEMA standards.

b. Motors:

- 1) Provide motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment, and having guarded dripproof type enclosures.
 - a) Unless otherwise indicated, provide motors complying with the requirements specified in NEMA MG 1.

3. Product Data:

- a. Prepare Product Data for the power ventilators listing rated capacities, furnished specialties, and accessories for each type of product indicated, and that includes the following information:
 - 1) Certified fan performance curves having the system operating conditions indicated.
 - 2) Certified fan sound-power ratings.
 - 3) Motor ratings, electrical characteristics, and motor and electrical accessories.
 - 4) Material gages, finishes, and color charts.
 - 5) Damper information, including housings, linkages, and operators.
- b. Submit the Product Data for the power ventilators to the Program/Project Manager for approval.

4. Shop Drawings:

- a. Prepare Shop Drawings for the power ventilators indicating installation and mounting details.
- b. Submit the Shop Drawings for the power ventilators to the Program/Project Manager for approval.

E. Equipment:

1. In-Line Centrifugal Fans:

- a. Provide in-line, direct-driven centrifugal fans consisting of a housing, a fan wheel, outlet guide vanes, a fan shaft, bearings, a motor and it's disconnect switch, a drive assembly, mounting brackets, and the specified accessories.



- b. Housing:
 - 1) Provide a split, spun aluminum housing having aluminum straightening vanes, inlet and outlet flanges, and a support bracket adaptable to floor, side wall, or ceiling mounting.
- c. Fan Wheels:
 - 1) Provide a fan wheel consisting of aluminum airfoil blades welded to an aluminum hub.
- d. Direct-Driven Units:
 - 1) Provide direct-driven units having a motor encased in a housing mounted outside of the airstream, and factory-wired to a disconnect switch located on the outside of fan housing.
- e. Accessories:
 - 1) Companion Flanges:
 - a) Provide companion flanges for the inlet and outlet duct connections.
 - 2) Fan Guards:
 - a) Provide fan guards consisting of a 1/2-inch by 1-inch galvanized steel mesh mounted in a removable frame.
 - b) For units not connected to ductwork, provide a guard for the inlet or outlet.
 - 3) Motor and Drive Cover (Belt Guard):
 - a) Provide epoxy-coated steel motor and drive cover.
- 2. Direct Drive Centrifugal Roof Exhaust Fans:
 - a. Spun aluminum, roof mounted, direct driven, down-blast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
 - b. Housing:
 - 1) The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gage marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit



shall bear an engraved aluminum nameplate and shall be shipped in ISTA Transit Tested Certified packaging.

- c. Fan Wheel:
 - 1) Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
- d. Motor:
 - 1) Motor shall be a DC electronic commutation type motor (ECM) specially designed for fan applications.
 - 2) Motor shall be heavy-duty type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.
 - 3) Motor shall be speed controllable down to 20% of full speed. Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - 4) Motor shall be a minimum of 85% efficient at all speeds.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Sound Test:
 - a. Test Procedure:
 - 1) Factory-test the fans in accordance with the requirements specified in ANSI/AMCA 300.
 - 2) Submit the Sound Test results to the Program/Project Manager for approval.
 - b. Acceptance Criteria:
 - 1) Fans within with the sound operating limits specified for the fan classification pass the Sound Test.
 - 2. Fan Performance Rating Tests:
 - a. Test Procedure:
 - 1) Determine the flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with the requirements specified in ANSI/AMCA 210.
 - 2) Submit the Fan Performance Rating Testing results to the Program/Project Manager for approval.
 - b. Acceptance Criteria:



- 1) Fans complying with the operating limits specified for the fan classification and the requirements specified in the Mechanical Equipment Schedule on the Contract Drawings pass the Fan Performance Rating Tests.
- B. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when power ventilators for this Contract are being assembled and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the elements and surfaces to receive power ventilator components for compliance with installation tolerances and other conditions affecting the performance of the Work.
 2. Examine the power ventilators before installation.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
 2. Reject power ventilators that are damaged or rusted.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the power ventilators.

3.03 INSTALLATION

- A. Install power ventilators level and plumb in accordance with the manufacturer's printed installation instructions at the locations indicated on the Contract Drawings.
 1. Submit the power ventilator manufacturer's printed installation instructions to the Program/Project Manager for information.



- B. Support power ventilators using restrained spring isolators complying with the requirements specified in Section 15060, Hangers and Supports, and having a static deflection of 1 inch.
- C. Wall-Mounted Ventilators:
 - 1. Secure wall-mounted fans to a sleeved mounting frame with cadmium-plated hardware.
- D. Ceiling Mounted Ventilators:
 - 1. Suspend units from the structure using threaded steel rods and spring hangers complying with the requirements specified in Section 15060, Hangers and Supports.
- E. Suspended Ventilators:
 - 1. Support suspended units from the structure using threaded steel rods and spring hangers complying with the requirements specified in Section 15060, Hangers and Supports.
 - 2. In seismic zones, restrain support suspended units in accordance with the requirements specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.
- F. Install units allowing clearances for service and maintenance.
- G. Label power ventilator units in accordance with the requirements specified in Section 15075, Mechanical Identification.
- H. Interface with Other Work:
 - 1. Ductwork Connections:
 - a. The Contract Drawings indicate the general arrangement of ducts and duct accessories.
 - b. Duct installation and connection requirements are specified in Section 15815, Metal Ducts, and Section 15820, Duct Accessories.
 - 1) Make final duct connections with flexible connectors.
 - a) Flexible connectors are specified in Section 15820, Duct Accessories.
 - c. When installing ducts that are adjacent to power ventilators, allow clearances for service and maintenance.
 - 2. Electrical Connections:
 - a. Provide electrical connections as indicated in the manufacturer's instructions.
 - b. Ground power ventilation equipment.
 - c. Tighten electrical connectors and terminals according to the manufacturer's published torque-tightening values.



- 1) If the manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when power ventilators are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Testing, Adjusting, and Balancing:
 - a. Test Procedure:
 - 1) For testing, adjusting, and balancing procedures, comply with the requirements specified in Section 15950, Testing, Adjusting, and Balancing.
 - a) Test and adjust controls and safeties.
 - b. Acceptance Criteria:
 - 1) Refer to the acceptance criteria specified in Section 15950, Testing, Adjusting, and Balancing.
3. Inspections:
 - a. The code-required Approved Agency must perform Special Inspections of smoke control systems, including fans; and of automatic shutoff systems for air distribution systems.

B. Non-Conforming Work

1. Remove malfunctioning units, replace the malfunctioning units with acceptable units, and retest the replacement units as specified herein.
 - a. Replace damaged and malfunctioning controls and equipment.



3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the ductwork, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

B. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that each unit is secure on its mountings and supporting devices, and that connection to ducts and of electrical components are complete.
3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect the fan drive from the motor, and verify proper motor rotation direction, fan wheel free rotation, and smooth bearing operation.
6. Reconnect the fan drive system, align and adjust the belts, and install the belt guards.
7. Verify lubrication for bearings and other moving parts has been provided.
8. In connected ductwork systems, verify that the manual and automatic volume control and the fire and smoke dampers are in the fully open position.
9. Disable automatic temperature-control operators.

C. Starting Procedure:

1. Energize the motor, and adjust the fan to the indicated rpm.
2. Measure and record the motor voltage and amperage.

D. Operational Test:

1. After the electrical circuitry has been energized, start the units to confirm proper motor rotation and unit operation.
2. Remove malfunctioning units, replace the removed units with new units, and retest the replacement units.

E. Shut the unit down, and reconnect the automatic temperature-control operators.

F. Replace fan and motor pulleys as required to achieve the design airflow.

G. Repair, or remove and replace, malfunctioning units.



1. Retest replacement units as specified herein after repairs are made or replacements are provided.

3.06 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

3.07 CLEANING

- A. After the power ventilator installation is complete, internally clean the fans according to the manufacturer's written instructions.
 1. Remove foreign material and construction debris.
 2. Vacuum the fan wheel and cabinet.
 3. Submit the power ventilator manufacturer's printed cleaning instructions to the Program/Project Manager for information.
- B. After the power ventilator installation is complete, including the outlet fitting and other devices, inspect the exposed finish.
 1. Remove burrs, dirt, and construction debris; and repair damaged finishes.
- C. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Training:
 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the power ventilators in accordance with the requirements specified in Section 01770, Closeout Procedures.
 - a. Train the Owner's maintenance personnel to understand the procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining the equipment and schedules.
 - b. Review the data in the emergency and Operation and Maintenance Manuals furnished as specified in Section 01780, Closeout Submittals.



3.09 PROTECTION

- A. Take steps to ensure that installed power ventilators are protected during subsequent construction activities.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data for the power ventilators to the Program/Project Manager for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15855

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for ceiling and wall mounted diffusers, registers and grilles.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 15820 – Duct Accessories.

1.02 REFERENCES

- A. Reference Standards:
 - 1. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the diffuser, register, and grille layout and installation with the layout and installation of duct, suspended ceilings, fire- and smoke-control dampers, lighting, and similar finished work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Data sheets.
 - 2) Diffuser, Register, and Grille Schedule



1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 - 1. Prevent contact with materials which may cause discoloration or staining.
- C. Packaging Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- C. Performance:
 - 1. Verification of Performance:
 - a. Provide diffusers, registers, and grilles provided as the Work of this Section that have been rated in accordance with the requirements specified in ANSI/ASHRAE 70.
- D. Design Criteria:



1. The Contract Drawings indicate the general arrangement of ducts, fittings, and accessories.
 - a. Air outlet and inlet locations to achieve the design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop have been indicated on the Contract Drawings.
 - b. Whenever practicable, locate the ceiling-mounted outlets and inlets in their final position where indicated on the Contract Drawings.
2. Product Data:
 - a. Submit Product Data for the products provided as the Work of this Section to the Program/Project Manager for approval, including the following information:
 - 1) Data Sheets:
 - a) Furnish a data sheet for each product provided as the Work of this Section indicating the materials of construction, the finish, mounting details, and performance data that indicates the throw and drop, static-pressure drop, and noise ratings.
 - 2) Diffuser, Register, and Grille Schedule:
 - a) Furnish a Diffuser, Register, and Grille Schedule that indicates the Contract Drawing designation, the room location, quantity, model number, size, and accessories furnished for all products provided as the Work of this Section.

E. Materials:

1. Grilles and Registers:
 - a. Adjustable Bar Grilles and Registers:
 - 1) Provide adjustable bar grilles and registers having the Model Number, capacities, and/or characteristics specified in the Diffuser and Register Schedule on the Contract Drawings.
 - 2) Manufacturers:
 - a) Krueger, www.krueger-hvac.com.
 - b) Price Industries, www.price-hvac.com.
 - c) Titus, www.titus-hvac.com.
 - d) Approved equal.
 - b. Fixed Face Ceiling Return Grilles:
 - 1) Provide fixed face ceiling return grilles having the Model Number, capacities, and/or characteristics specified in the Diffuser and Register Schedule on the Contract Drawings.
 - 2) Manufacturers:
 - a) Krueger, www.krueger-hvac.com.
 - b) Price Industries, www.price-hvac.com.
 - c) Titus, www.titus-hvac.com.
 - d) Approved equal.



- c. Fixed Face Sidewall Return Grille.
 - 1) Provide fixed face sidewall return grilles having the Model Number, capacities, and/or characteristics specified in the Diffuser and Register Schedule on the Contract Drawings.
 - 2) Manufacturers:
 - a) Krueger, www.krueger-hvac.com.
 - b) Price Industries, www.price-hvac.com.
 - c) Titus, www.titus-hvac.com.
 - d) Approved equal.
- 2. Ceiling Diffuser Outlets:
 - a. Rectangular, Round and Square Ceiling Diffusers:
 - 1) Provide rectangular, round and square ceiling diffusers having the Model Number, capacities, and/or characteristics specified in the Diffuser and Register Schedule on the Contract Drawings.
 - 2) Manufacturers:
 - a) Krueger, www.krueger-hvac.com.
 - b) Price Industries, www.price-hvac.com.
 - c) Titus, www.titus-hvac.com.
 - d) Approved equal.

2.02 ACCESSORIES

- A. Combination Fire and Smoke Dampers and Volume-Control Dampers:
 - 1. Combination fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles are specified in Section 15820, Duct Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the areas where diffusers, registers, and grilles are to be installed for compliance with the requirements for installation tolerances and other conditions affecting performance of the equipment.
 - a. Where architectural features or other items conflict with the installation, notify the Program/Project Manager for a determination of final location.
- B. Evaluation and Assessment:
 - 1. Do not proceed to install diffusers, registers, and grilles until unsatisfactory conditions have been corrected.



3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the diffusers, registers, and grilles.

3.03 INSTALLATION

- A. Install diffusers, registers, and grilles to be level and plumb.
- B. Ceiling-Mounted Outlets and Inlets:
 - 1. For units installed in lay-in ceiling panels, locate the units in the center of the panel.
- C. Interface with Other Work:
 - 1. Install diffusers, registers, and grilles so their connections to ducts are airtight, and easy access for servicing and maintaining dampers and other similar duct accessories is provided.

3.04 ADJUSTING

- A. After the diffusers, registers, and grilles are installed but before starting air balancing procedures, adjust the diffusers, registers, and grilles so the air patterns indicated in the Contract Documents are achieved, or adjust the diffusers, registers, and grilles as directed by the Program/Project Manager.

3.05 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Take steps to ensure that the installed diffusers, registers, and grilles are protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15861

AIR FILTERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for air filters and accessories, including the following types:
 - a. Flat panel filters.
 - b. Pleated panel filters.
 - c. Supported bag filters.
 - d. V-bank cell filters.
 - e. Front- and rear-access filter frames.
 - f. Side-service housings.
 - g. Filter gages.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 – Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. HVAC: Heating, ventilating, and air-conditioning.
 - 2. SCAQMD: An acronym for South Coast Air Quality Management District, the pollution control agency for Los Angeles, Riverside, and San Bernardino counties in California.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
 - 4. w. g.: Water gauge.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Minimum Efficiency Reporting Value (MERV): A value from 1 to 16 that along with an associated air velocity represents the efficiency of a filter, and which is based on testing using different particle sizes, 1 of 7 approved flow velocities, and the required number of repeat cycles as specified in ASHRAE 52.2.
 - a. The flow velocity used to determine a MERV value must be stated with the MERV value for the MERV number to be meaningful.



- b. The higher the MERV number, the higher the velocity.

C. Reference Standards:

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter [*withdrawn*].
 - b. ANSI/ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - c. ASHRAE 62.1-2004 – Ventilation for Acceptable Indoor Air Quality.
2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 90A – Standard for Installation of Air-Conditioning and Ventilating Systems.
 - c. NFPA 90B - Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. SMACNA IAQ Guidelines for Occupied Buildings Under Construction.
6. South Coast Air Quality Management District (SCAQMD):
 - a. SCAQMD Rule 1168 – Adhesive and Sealant Applications.
7. Underwriters Laboratories, Inc. (UL):
 - a. UL 900 – Standard for Air Filters.
8. United States Government:
 - a. Environmental Protection Agency (EPA):
 - 1) 40 CFR 59 – National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate filter installations with duct and air-handling-unit installations.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:



- 1) Flat panel filters.
 - 2) Pleated panel filters.
 - 3) Supported bag filters.
 - 4) V-bank cell filters.
 - 5) Front-access and rear-access filter frames.
 - 6) Side-service housings.
 - 7) Diaphragm-type filter gages.
 - 8) Manometer-type filter gages.
 - b. Shop Drawings:
 - 1) Air filters.
 - 2) Air filter wiring diagrams.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Site Quality Control Submittals:
 - 1) Leak Test and Inspection Reports.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for each type of filter and rack.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Extra Stock Materials:
 - 1) Furnish extra stock materials that match the products installed in the following quantities, and package the extra stock materials with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Filters:
 - (1) Furnish 1 complete set of filters for each filter bank.
 - (2) If a system includes prefilters, provide only prefilters.
 - b) Red Oil:
 - (1) Furnish 1 container of red oil for inclined manometer filter gages.

1.05 QUALITY ASSURANCE

- A. Certifications:
 1. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing



agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.

- 1) Provide products marked with their intended use or classification.
- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver filter materials in their original, unopened containers bearing the name of the manufacturer, product identification, and reference to third party testing, such as testing by FM Approvals LLC (FM) or Underwriters Laboratories, Inc. (UL).
- B. Storage and Handling Requirements:
 1. Store the filter materials inside under cover, off the ground, and in a dry location.
 - a. Protect filter materials from physical damage and from deterioration due to moisture, soiling, and other sources.
 2. Comply with the filter material manufacturer's written instructions for handling, storing, and protecting the material during installation.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 AIR FILTER ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
- 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - 2. Sustainability Requirements:
 - a. Indoor Air Quality (IAQ):
 - 1) Provide air filters that comply with the minimum indoor air quality (IAQ) requirements specified in Section 4 - Outdoor Air Quality, Section 5 - Systems and Equipment, and Section 7 - Construction and Startup, in ASHRAE 62.1-2004 for minimum ventilation rates, surfaces in contact with the airstream, particulate and gaseous filtration, and equipment access.
 - 2) Prepare and implement a Construction IAQ Management Plan that complies with the requirements specified in SMACNA IAQ Guidelines for Occupied Buildings Under Construction.
 - a) Protect absorptive materials installed or stored onsite from moisture damage.
 - b) For permanently installed air handlers used during construction, provide filtration media having a Minimum Efficiency Reporting Value (MERV) of 8 determined in accordance with the method specified in ANSI/ASHRAE 52.2 at each return grille.
 - b. Volatile Organic Compounds (VOC) Content of Interior Adhesives and Sealants:
 - 1) Provide interior adhesives, sealants, and adhesive and sealant primers for this Contract having volatile organic compound content falling within the following limits when calculated according to Environmental Protection Agency (EPA) Method 24 as described in 40 CFR 59, and that comply with SCAQMD Rule 1168:
 - a) Contact Adhesive: Not more than 80 grams per Liter less water.
 - b) Fiberglass Adhesives: Not more than 80 grams per Liter less water.
- C. Performance:
- 1. Arrestance:



- a. Provide air filters having the specified arrestance when tested and rated as specified in ASHRAE 52.1
 - 2. Minimum Efficiency Reporting Value (MERV):
 - a. Provide air filters having the specified minimum efficiency reporting value (MERV) when tested and rated as specified in ASHRAE 52.2.
- D. Design Criteria:
 - 1. Air Filter Unit Class:
 - a. Provide air filters complying with the requirements for Class 1 and Class 2 filters specified in UL 900.
 - 2. Air Filter Sizes:
 - a. Provide air filters of the sizes indicated in the Mechanical Equipment Schedule on the Contract Drawings.
 - 3. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of product proposed for the Work of this Contract.
 - 1) Include dimensions; operating characteristics; the required clearances and access space; the rated flow capacity, including the initial and final pressure drops at the rated airflow; the efficiency and test method measuring the efficiency; the fire classification; the furnished specialties; and the accessories for each model indicated.
 - b. Submit the manufacturer's Product Data to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Prepare Shop Drawings for the air filters.
 - 1) Include plans, elevations, sections, details, and attachments to other work.
 - a) Show filter rack assemblies, dimensions, materials, and methods of assembly of components.
 - b) Include setting drawings, templates, and the requirements for installing anchor bolts and anchorages.
 - b. Prepare wiring diagrams for the power, signal, and control wiring for the air filters.
 - c. Submit the Shop Drawings and wiring diagrams to the Program/Project Manager for approval.
- E. Manufactured Units:
 - 1. Flat Panel Filters:
 - a. Provide factory-fabricated, self-supported, flat, non-pleated, panel-type, carbon impregnated with potassium, disposable air filters having holding frames.
 - b. Media:
 - 1) Provide interlaced glass or synthetic fibers coated with nonflammable adhesive and an antimicrobial agent, and that is impregnated with activated carbon with potassium.



- 2) Provide a metal retainer on both the upstream side and downstream side of the media.
- c. Filter-Media Frame:
 - 1) Provide a hinged, galvanized steel filter-media frame having a metal grid on the outlet side and a steel rod grid on inlet side, and having pull and retaining handles sealed or bonded to the media.
- d. Mounting Frames:
 - 1) Provide welded galvanized steel mounting frames having gaskets and fasteners, and that are suitable for bolting together into built-up filter banks.
- e. Manufacturers:
 - 1) AAF International, <http://www.aafintl.com>.
 - 2) CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - 3) Camfil Farr, <https://www.camfil.us/Products/>.
 - 4) Filtration Group, <http://www.filtrationgroup.com>.
 - 5) Koch Filter Corporation, <http://www.kochfilter.com>.
 - 6) Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - 7) Approved equal.
2. Pleated Panel Filters:
 - a. Provide factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters having holding frames.
 - b. Media:
 - 1) Provide interlaced glass or synthetic fibers coated with nonflammable adhesive and an antimicrobial agent.
 - 2) Provide separators bonded to the media to maintain the pleat configuration.
 - 3) Provide a welded wire grid on the downstream side of the media to maintain the pleat.
 - 4) Bond the media to the filter-media frame to prevent air bypass.
 - 5) Provide support members on the upstream and downstream sides to maintain the pleat spacing.
 - c. Filter-Media Frame:
 - 1) Provide cardboard filter-media frames with perforated metal retainers sealed or bonded to the media.
 - d. Mounting Frames:
 - 1) Provide welded galvanized steel mounting frames having gaskets and fasteners, and that are suitable for bolting together into built-up filter banks.
 - e. Capacities and Characteristics:
 - 1) Efficiency:
 - a) Provide pleated panel filters having an efficiency of 90 percent on particles 20 micrometers and larger at 500 feet per minute (2.5m/s).
 - 2) Arrestance:



- a) Provide pleated panel filters having an arrestance of 85 percent when tested in accordance with the method specified in ASHRAE 52.1.
 - 3) Minimum Efficiency Reporting Value (MERV) Rating:
 - a) Provide pleated panel filters having a minimum efficiency reporting value (MERV) of 13 when tested in accordance with the method specified in ASHRAE 52.2.
 - f. Manufacturers:
 - 1) AAF International, <http://www.aafintl.com>.
 - 2) CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - 3) Camfil Farr, <https://www.camfil.us/Products/>.
 - 4) Filtration Group, <http://www.filtrationgroup.com>.
 - 5) Koch Filter Corporation, <http://www.kochfilter.com>.
 - 6) Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - 7) Approved equal.
3. Supported Bag Filters:
- a. Provide factory-fabricated, dry, extended-surface, self-supported bag filters having holding frames in steel, basket-type retainers.
 - b. Media:
 - 1) Provide fibrous material constructed so individual pleats are maintained in a tapered form under the rated-airflow conditions by flexible internal supports.
 - 2) Provide media coated with an antimicrobial agent.
 - c. Filter-Media Frames:
 - 1) Provide galvanized steel filter-media frames.
 - d. Mounting Frames:
 - 1) Provide welded galvanized steel mounting frames having gaskets and fasteners, and that are suitable for bolting together into built-up filter banks.
 - e. Capacities and Characteristics:
 - 1) Arrestance:
 - a) Provide supported bag filters having an arrestance of 85 percent when tested in accordance with the method specified in ASHRAE 52.1.
 - 2) Minimum Efficiency Reporting Value (MERV) Rating:
 - a) Provide supported bag filters having a minimum efficiency reporting value (MERV) of 8 when tested in accordance with the method specified in ASHRAE 52.2.
 - f. Manufacturers:
 - 1) AAF International, <http://www.aafintl.com>.
 - 2) CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - 3) Camfil Farr, <https://www.camfil.us/Products/>.
 - 4) Filtration Group, <http://www.filtrationgroup.com>.



- 5) Koch Filter Corporation, <http://www.kochfilter.com>.
 - 6) Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - 7) Approved equal.
4. V-Bank Cell Filters:
- a. Provide factory-fabricated, adhesive-coated, disposable, packaged air filters having their media angled with respect to the airflow, and having holding frames.
 - b. Media:
 - 1) Provide fibrous material constructed so individual pleats are maintained in tapered form under the rated-airflow conditions by flexible internal supports.
 - 2) Provide media coated with an antimicrobial agent.
 - c. Filter-Media Frames:
 - 1) Provide galvanized steel filter-media frames.
 - d. Mounting Frames:
 - 1) Provide welded galvanized steel mounting frames having gaskets and fasteners, and that are suitable for bolting together into built-up filter banks.
 - e. Capacities and Characteristics:
 - 1) Arrestance:
 - a) Provide V-bank cell filters having an arrestance of 85 percent when tested in accordance with the method specified in ASHRAE 52.1.
 - 2) Minimum Efficiency Reporting Value (MERV) Rating:
 - a) Provide V-bank cell filters having a minimum efficiency reporting value (MERV) of 8 when tested in accordance with the method specified in ASHRAE 52.2.
 - f. Manufacturers:
 - 1) AAF International, <http://www.aafintl.com>.
 - 2) CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - 3) Camfil Farr, <https://www.camfil.us/Products/>.
 - 4) Filtration Group, <http://www.filtrationgroup.com>.
 - 5) Koch Filter Corporation, <http://www.kochfilter.com>.
 - 6) Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - 7) Approved equal.

2.02 ACCESSORIES

- A. Front-Access and Rear-Access Filter Frames:
1. Framing System:
 - a. Provide galvanized-steel framing members having access for either upstream (front) or downstream (rear) filter servicing.
 - b. Cut the galvanized-steel framing members to size, and pre-punch the framing members for assembly into modules.



- c. Vertically support the filters to prevent deflection of the horizontal members without interfering with either filter installation or operation.
 2. Prefilters:
 - a. Incorporate a separate track for prefilters that are removable from either the front or back, and that has spring clips.
 3. Sealing:
 - a. Provide a factory-installed, positive-sealing device for each row of filters that ensures a seal between the gasketed filter elements, and prevents bypass of unfiltered air.
 4. Manufacturers:
 - a. AAF International, <http://www.aafintl.com>.
 - b. CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - c. Camfil Farr, <https://www.camfil.us/Products/>.
 - d. Filtration Group, <http://www.filtrationgroup.com>.
 - e. Koch Filter Corporation, <http://www.kochfilter.com>.
 - f. Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - g. Approved equal.
- B. Side-Service Housings:
 1. Provide factory-assembled, side-service housings constructed of galvanized steel, and having flanges to connect to the duct or casing system.
 2. Prefilters:
 - a. Provide integral tracks that accommodate 2-inch (50mm-) deep, disposable filters.
 3. Access Doors:
 - a. Provide hinged access doors having continuous gaskets on their perimeters and positive-locking devices.
 - b. Arrange the access doors so the filter cartridges can be loaded from either access door.
 4. Sealing:
 - a. Incorporate positive-sealing gasket material on channels to seal the top and bottom of the filter cartridge frames and to prevent bypass of unfiltered air.
 5. Manufacturers:
 - a. AAF International, <http://www.aafintl.com>.
 - b. CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - c. Camfil Farr, <https://www.camfil.us/Products/>.
 - d. Filtration Group, <http://www.filtrationgroup.com>.
 - e. Koch Filter Corporation, <http://www.kochfilter.com>.
 - f. Purafil, Inc., <http://www.purafil.com/index.aspx>.
 - g. Approved equal.
- C. Filter Gages:



1. Diaphragm-Type Filter Gages:
 - a. Provide diaphragm-type filter gages having a dial and pointer in a metal case, vent valves, black figures on a white background, a front recalibration adjustment, and the following additional features:
 - 1) Diameter:
 - a) Provide filter gages having 4-1/2-inch (115mm) diameter.
 - 2) Scale Range:
 - a) For filter media having a recommended final resistance of 0.5-Inch w. g. (125Pa) or less, provide filter gages having a scale range or 0 inch w. g. to 0.5 inch w. g. (0Pa to 125Pa).
 - b) For filter media having a recommended final resistance of 0.5 inch w. g. to 1.0 Inch w. g. (125Pa to 250Pa) or less, provide filter gages having a scale range or 0 inch w. g. to 1.0 inch w. g. (0Pa to 250Pa).
 - c) For filter media having a recommended final resistance of 1.0 inch w. g. to 2.0 Inch w. g. (250Pa to 500Pa) or less, provide filter gages having a scale range or 0 inch w. g. to 2.0 inch w. g. (0Pa to 500Pa).
 - d) For filter media having a recommended final resistance of 2.0 inch w. g. to 3.0 Inch w. g. (500Pa to 750Pa) or less, provide filter gages having a scale range or 0 inch w. g. to 3.0 inch w. g. (0Pa to 750Pa).
 - e) For filter media having a recommended final resistance of 3.0 inch w. g. to 4.0 Inch w. g. (750Pa to 1000Pa) or less, provide filter gages having a scale range or 0 inch w. g. to 4.0 inch w. g. (0Pa to 1000Pa).
2. Manometer-Type Filter Gages:
 - a. Provide molded plastic manometer-type filter gages having an epoxy-coated aluminum scale and logarithmic-curve tube gage with an integral leveling gage, and graduated to read from 0- to 3.0-inch w. g. (0Pa to 750Pa), and accurate within 3 percent of the full scale range.
3. Accessories:
 - a. Provide static-pressure tips, tubing, gage connections, and mounting brackets.
4. Manufacturers:
 - a. CLARCOR Air Filtration Products, Inc., Airguard®, <http://www.airguard.com>.
 - b. Dwyer Instruments, Inc., <http://www.dwyer-inst.com>.
 - c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the air filters in accordance with the requirements specified in NFPA 90A and NFPA 90B, as applicable.



- B. Position each filter unit so clearance for normal service and maintenance is provided.
 - 1. Anchor filter holding frames to the substrate.
- C. Install filters in position to prevent the passage of unfiltered air.
- D. Filter Gages:
 - 1. Install a filter gage for each filter bank.
 - a. Install filter-gage, static-pressure taps upstream and downstream from the filters.
 - b. Install the filter gages on the filter banks using separate static-pressure taps upstream and downstream from the filters.
 - c. Mount the filter gages on the outside of the filter housing or filter plenum in an accessible position.
 - 2. Adjust and level inclined gages.
- E. Special Techniques:
 - 1. Do not operate fan system until temporary or permanent filters are in place.
 - 2. Replace temporary filters used during construction and testing with new, clean filters.

3.02 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Leak Test:
 - a. Test Procedure:
 - 1) While the system is operating, check the system for leakage of unfiltered air.
 - 2) Prepare test and inspection reports for the Leak Test, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Systems showing no leakage of unfiltered air pass the Leak Test.
- B. Non-Conforming Work
 - 1. An air filter will be considered defective if it does not pass the tests and inspections.
- C. Manufacturer Services:
 - 1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.03 SYSTEM STARTUP

- A. Operate automatic roll filters to demonstrate they comply with the specified requirements.



3.04 CLEANING

- A. After completing the installation, testing, adjusting, and balancing of air-handling and air-distribution systems, clean their filter housings and install new filter media.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.05 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for each type of filter and rack for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 - 2. Submit the operation and maintenance data for the filters and racks and components to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for instrumentation and control equipment for heating, ventilating, and air-conditioning (HVAC) systems and components, including the control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01770 - Closeout Procedures.
4. Section 01780 - Closeout Submittals.
5. Section 01810 - Commissioning.
6. Section 15815 - Metal Ducts.
7. Section 15820 - Duct Accessories.
8. Section 16120 - Conductors and Cables.
9. Section 16123 - Control-Voltage Power Cables.
10. Section 16130 - Raceway and Boxes.
11. Section 15995 – Commissioning of Mechanical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. BACnet: Building automation and control networks.
2. CFM: Cubic feet per minute.
3. HVAC: Heating, Ventilating, and Air-Conditioning.
4. w. g.: Water gauge.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Internet: A global system of interconnected computer networks that use the standard Internet Protocol Suite (TCP/IP) to serve a multitude of users worldwide.



3. Intranet: A private computer network that uses Internet Protocol technologies to securely share any part of an organization's information or operational systems within that organization.

C. Reference Standards:

1. Air Movement and Control Association International, Inc. (AMCA):
 - a. AMCA 11 – Certified Ratings Program Operating Manual.
 - b. AMCA 511 - Certified Ratings Program – Product Rating Manual for Air Control Devices.
 - c. ANSI/AMCA 500-D – Laboratory Methods of Testing Dampers for Rating.
 - d. ANSI/AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE 135 – A Data Communications Protocol for Building Automation and Control Networks (BACnet).
 - b. ANSI/ASHRAE 135.1 – Method of Test for Conformance to BACnet.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the items furnished, and interfaces, connection points, and methods with the appropriate Subcontractors to ensure a complete and operable system is provided.
 - a. Coordinate the locations of thermostats, temperature sensors, and other exposed control sensors with the Contract Drawings and room details before installation.



- b. Take responsibility for control wiring, final connections, wiring methods and coordination to provide a source of power as required.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Web server computers and monitors.
- 2) Web server software.
- 3) Electronic sensors.
- 4) Temperature sensors.
- 5) Electric actuator motors.
- 6) Damper actuators.
- 7) Dampers.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Manufacturer's Instructions:

- 1) Heating, ventilating, and air-conditioning (HVAC) instrumentation and control system manufacturers' written installation instructions.

b. Site Quality Control Submittals:

- 1) Calibration Test reports.
- 2) Operational Test reports.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Operation and Maintenance Data:

- 1) Heating, ventilating, and air-conditioning (HVAC) system instrumentation and control operation and maintenance data.

b. Software:

- 1) Backup copies of the user interface software.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Listing and Labeling of Electrical Components, Devices, and Accessories:

- a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing



agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.

- 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Special Inspections:
- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
3. Testing and Inspection Agencies:
- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Certifications:

1. Air Movement and Control Association International, Inc. (AMCA)
Licensed Products:
 - a. Motorized Control Dampers:



- 1) Provide only motorized control dampers that have been licensed to bear the AMCA seals by having participated in the AMCA Certified Ratings Program.
 - a) Comply with the procedures and testing requirements for performance rating fans specified in AMCA 11, AMCA 511, ANSI/AMCA 500-D, and ANSI/AMCA 500-L.
 - b) Provide only motorized control dampers labeled with the AMCA Certified Ratings Seals.

1.06 STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 1. Keep each heating, ventilating, and air-conditioning (HVAC) instrument and control in its package or otherwise protected until it is time to install it.
 2. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
- C. Packaging Waste Management:
 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 HVAC INSTRUMENTATION AND CONTROL SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Alerton, www.alerton.com.
 - b. Delta Controls Corp., www.deltacontrols.com.
 - c. Johnson Controls, Inc., www.johnsoncontrols.com.
 - d. Schneider Electric, <https://www.schneider-electric.com>.
 - e. Approved equal.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 1. Regulatory Requirements:



- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide electrical products and installation complying with requirements specified in NFPA 70.
- C. Performance:
- 1. Provide a new control system that is capable of total integration with the existing Johnson Controls, Inc. facility infrastructure systems, and providing user access to all system data, either locally over a secure Intranet within the building, or by remote access by a standard web browser over the Internet.
 - 2. Damper Operating Temperature Range:
 - a. Provide dampers capable of operating within the operating temperature range from minus 40 degrees Fahrenheit to plus 200 degrees Fahrenheit.
- D. Design Criteria:
- 1. The Contract Drawings are diagrammatic, and only indicate the general arrangement of the mechanical controls, equipment; piping, fittings, ducts, and specialties.
 - 2. Provide a complete and operating heating, ventilating, and air-conditioning (HVAC) control system utilizing direct digital controls (DDC) as shown on the Contract Drawings and described herein.
 - a. Provide all additional hardware and software required for the specific application.
 - b. Provide a heating, ventilating, and air-conditioning (HVAC) instrumentation and control system designed in accordance with the requirements for the BACnet standard specified in ANSI/ASHRAE 135.
 - 3. Hardware and Software:
 - a. Provide a new web server computer at the Site having the most current edition of the control manufacturer's web server software installed.
 - 4. Product Data:
 - a. Prepare Product Data for the products proposed for the Work of this Section, including the manufacturer's technical literature for each control device indicated, labeled with the setting or adjustable range of control.



- 1) Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- b. Submit the Product Data to the Program/Project Manager for approval.

E. Components:

1. Web Server Computers, Monitors, and Software:

a. Web Server Computers:

- 1) Provide computers for the web server complying with the following minimum requirements:
- 2) Processors:
 - a) Provide Pentium 4 processors in the computers having a 1 Gigahertz (GHz) processing speed and 512 Megabytes (MB) of random access memory.
- 3) Ethernet Ports:
 - a) Provide at a minimum two 10/100 Ethernet connection ports.

b. Web Server Computer Monitors:

- 1) Provide computer monitors for the web server complying with the following minimum requirements:
- 2) Monitor Screen Resolution:
 - a) Provide computer monitors having at a minimum a screen resolution of 1024 pixels by 768 pixels (16bit).

c. Web Server Software:

- 1) Provide Microsoft Windows-based user interface software compatible with Microsoft Windows XP pro Edition software and/or compatible with Microsoft Windows 2003 Web Server software.
 - a) Third party viewing software, such as 'Close-Up' or 'PC Anywhere' is unacceptable.
 - b) All software platforms shall be submitted to and approved by the Airport prior to purchase.
- 2) Submit backup copies of the user interface software to the Program/Project Manager.

2. Sensors:

a. Electronic Sensors:

- 1) Provide vibration and corrosion resistant electronic sensors suitable for wall mounting.

b. Temperature Sensors:

- 1) Provide thermistor type temperature sensors having the following properties and/or features:
 - a) Accuracy:



- (1) Provide temperature sensors having an accuracy of plus or minus 0.5 degrees Fahrenheit at the calibration point.
 - b) Wire:
 - (1) Provide twisted, shielded-pair cable.
 - c) Outside-Air Sensors:
 - (1) Provide watertight, inlet fitting outside-air sensors shielded from direct sunlight.
 - d) Room Security Sensors:
 - (1) Provide room security sensors having a stainless-steel cover plate with an insulated back and security screws.
- 3. Actuators:
 - a. Electric Actuator Motors:
 - 1) Provide electric motors sized to have sufficient reserve power to operate either with a smooth modulating action or with two-position action.
 - b. Damper actuators:
 - 1) Provide spring return type damper actuators.
 - 2) Provide direct-mount type two position or proportional electric actuators sized to provide a minimum of 5 inch-pounds of torque per square foot of damper area.
- 4. Dampers:
 - a. Provide AMCA-rated, opposed-blade design control dampers.
 - b. Damper Frame:
 - 1) Provide galvanized steel damper frames a minimum of 0.1084 inch thick, and having holes for duct mounting.
 - c. Damper Blades:
 - 1) Provide galvanized steel damper blades a minimum of 0.0635 inch thick, and having a maximum blade width of 8 inches.
 - 2) Using zinc-plated hardware, secure the damper blades to 1/2-inch diameter, zinc-plated axles having nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 3) For standard applications, provide optional closed-cell neoprene edging.
 - 4) For low-leakage applications, provide parallel-blade or opposed-blade design damper blades having inflatable seal blade edging, or replaceable rubber seals, rated for leakage when tested in accordance with the requirements specified in ANSI/AMCA 500-D of less than 10 cubic feet per minute (cfm) per square foot of damper area at a differential pressure of 4 inches w. g. when the damper is being held by a torque of 50 inch-pounds-force.



2.02 ACCESSORIES

- A. Cable Trays:
 - 1. Provide cable trays complying with the requirements specified in Section 16134, Cable Trays.
- B. Control Cable:
 - 1. For control wiring, provide electronic cable complying with the requirements specified in Section 16123, Control-Voltage Power Cables.
 - a. Plenum rated cable is unacceptable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify the location of thermostats and other exposed control sensors with the Contract Drawings and room details before installing the instrumentation and controls.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system.

3.03 INSTALLATION

- A. Install the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system in accordance with the requirements specified in NFPA 90A, and the manufacturer's installation instructions.
 - 1. Install heating, ventilating, and air-conditioning (HVAC) instrumentation and control equipment level and plumb.
 - 2. Submit the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system manufacturers' written installation instructions to the Program/Project Manager for information.
- B. Thermostats:
 - 1. Locate the thermostats 48 inches above the floor.
 - 2. For thermostats installed in the following locations, provide guards on the thermostats:
 - a. In public areas.
 - b. Where indicated on the Contract Drawings.



C. Dampers:

1. Install automatic dampers in accordance with the appropriate requirements specified in Section 15820, Duct Accessories.
2. Install damper motors on the outside of duct in warm areas, not in locations exposed to outdoor temperatures.
3. Install duct volume-control dampers in accordance with the appropriate requirements specified in other Sections specifying air ducts, including Section 15815, Metal Ducts, and Section 15820, Duct Accessories.

D. Special Techniques:

1. Refrigerant Equipment:

- a. Install refrigerant instrument wells, valves, and other accessories in accordance with the appropriate requirements specified in Section 15186, Refrigerant Piping.
 - 1) Install piping adjacent to the equipment in a location that will allow for service and maintenance of the equipment.

2. Identification:

- a. To identify control components, install labels and nameplates in accordance with the appropriate requirements specified in Section 15075, Mechanical Identification.
 - 1) Except for local individual room control cables, number-code or color-code the conductors for future identification and service of the control system.

E. Systems Integration:

1. For line and low voltage wiring and raceway, comply with the following requirements for the appropriate item:
 - a. Install raceways, boxes, and cabinets in accordance with the appropriate requirements specified in Section 16130, Raceway and Boxes.
 - b. Install electronic signal and communication cables in accordance with the appropriate requirements specified in Section 16123, Control-Voltage Power Cables.
 - c. Install building wire and cable in accordance with the appropriate requirements specified in Section 16120, Conductors and Cables.
 - d. Install cable trays in accordance with the appropriate requirements specified in Section 16134, Cable Trays.
2. Except in mechanical rooms and areas where other conduit and piping are exposed, conceal the cable.
3. Install exposed cable in raceway painted white for ease of identification in the field.



4. Where several cables follow a common path, bundle and harness multi-conductor instrument cable in lieu of running single cables.
5. For flexible conductors bridging cabinets and doors, fasten the conductors along the hinge side of the cabinet or door.
 - a. Protect the flexible conductors against abrasion.
 - b. Tie and support the conductors.
6. Ground heating, ventilating, and air-conditioning (HVAC) instrumentation and control equipment in accordance with the requirements specified in 16061, Electrical Grounding and Bonding.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system is being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Calibration Test:
 - a. Test Procedure:
 - 1) Test the calibration of the heating, ventilating, and air-conditioning (HVAC) controllers by disconnecting the input sensors, and stimulating operation using a compatible signal generator.
 - a) Adjust, calibrate, and fine tune circuits and equipment to achieve the sequence of operation specified.
 - 2) Prepare and submit certified test reports documenting the calibration testing to the Program/Project Manager for information:
 - b. Acceptance Criteria:



- 1) Heating, ventilating, and air-conditioning (HVAC) instruments and controls having proper calibration pass the Calibration Test.
3. Operational Test:
 - a. Test Procedure:
 - 1) After installing the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system, and after its electrical circuitry has been energized, start instrumentation and control units to confirm their proper unit operation and compliance with the requirements specified.
 - a) Start, test, and adjust the control systems.
 - b) Demonstrate compliance with the specified requirements, including calibration and testing, and control sequences.
 - 2) Prepare and submit certified test reports documenting the operational testing to the Program/Project Manager for information:
 - b. Acceptance Criteria:
 - 1) Heating, ventilating, and air-conditioning (HVAC) instruments and controls operating normally pass the Operational Test.

B. Non-Conforming Work

1. Remove malfunctioning units, replace the malfunctioning units with acceptable units, and retest the replacement units as specified herein.
 - a. Replace damaged and malfunctioning controls and equipment.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the ductwork, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.06 ADJUSTING

A. Test and adjust controls and safeties.

B. Occupancy Adjustments:

1. When requested by Owner within one year of the date of Substantial Completion, furnish up to 3 Site visits to adjust and calibrate components, and to assist the Owner's personnel to make program changes and adjust sensors and controls to suit actual conditions.



3.07 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Training:

1. Train the Owner's maintenance personnel to adjust, operate, and maintain the heating, ventilating, and air-conditioning (HVAC) instrumentation and control system in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- A. Take steps to ensure that installed heating, ventilating, and air-conditioning (HVAC) system instrumentation and controls are protected during subsequent construction activities.

3.10 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the heating, ventilating, and air-conditioning (HVAC) system instrumentation and controls for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
2. Submit the operation and maintenance data for the heating, ventilating, and air-conditioning (HVAC) system instrumentation and controls to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for testing, adjusting, and balancing the heating, ventilating, and air-conditioning (HVAC) systems.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01330 - Submittal Procedures.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 01810 - Commissioning.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. BAS: Building Automation System.
 - 2. CA: Commissioning Authority.
 - 3. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 4. RA: Return air.
 - 5. SA: Supply air.
 - 6. TAB: Testing, Adjusting, and Balancing.
- B. Reference Standards:
 - 1. Air Movement and Control Association International, Inc. (AMCA):
 - a. AMCA 201 – Fans and Systems.
 - 2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE 111 – Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
 - 3. Associated Air Balance Council (AABC).
 - a. AABC National Standards for Total System Balance.
 - b. AABC Test and Balance Procedures.
 - 4. National Environmental Balancing Bureau (NEBB):
 - a. NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. SMACNA HVAC Systems–Duct Design.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the testing, adjusting, and balancing of mechanical systems and equipment with the commissioning activities performed by the Commissioning Authority (CA) under Section 01810, Commissioning.
 - a. Prior to performing testing and balance for each given area, have the required pre-functional checklists, calibrations, startup, and selected functional tests of the systems completed and approved by the Commissioning Authority (CA).
2. Coordinate the testing, adjusting, and balancing of mechanical systems and equipment with the Test and Balance Engineer.
 - a. Furnish the unique instruments needed for setting terminal unit boxes, such as a handheld control system interface, to the Test and Balance Engineer for use around the building during testing and balance activities, and instruct the Test and Balance Engineer to properly use the instruments if required.
 - b. Either furnish a qualified technician to assist the Test and Balance Engineer to operate controls while he or she is performing testing and balance activities, or provide sufficient training for the Test and Balance Engineer so he or she can operate systems without assistance.
3. Coordinate the efforts of the factory-authorized service representatives for systems and equipment, heating, ventilating, and air-conditioning (HVAC) controls installers, and other mechanics to operate the HVAC systems and equipment to support and assist testing, adjusting, and balancing (TAB) activities.
4. Partial Owner Occupancy:
 - a. The Owner may occupy completed areas of the building before the date of Substantial Completion.
 - b. Cooperate fully with the Owner during testing, adjusting, and balancing (TAB) operations to minimize conflicts with the Owner's operations.

B. Pre-Installation Meetings:

1. Prior to beginning testing and balance activities, convene a meeting with the Commissioning Authority (CA) in accordance with the requirements specified in Section 01316, Project Meetings; and review the Testing, Adjusting, and Balancing (TAB) Plan to determine the capabilities of the control system regarding completion of the testing and balance activities.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Special Procedure Submittals:
 - 1) Preliminary outline of the Testing, Adjusting, and Balancing (TAB) Plan.
 - 2) Testing, Adjusting, and Balancing (TAB) Plan.
 - 3) Reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests.
 - b. Qualification Statements:
 - 1) Test and Balance Engineer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Fan and Outlet Testing, Adjusting, and Balancing (TAB) Field Test Reports.
 - 2) Motor Testing, Adjusting, and Balancing (TAB) Field Test Reports.
 - 3) Temperature-Control Testing, Adjusting, and Balancing (TAB) Field Test Reports.
 - 4) Draft Final Testing, Adjusting, and Balancing (TAB) Report.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) National Project Performance Guarantee.
 - b. Record Documentation:
 - 1) Final Testing, Adjusting, and Balancing (TAB) Report.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Test and Balance Engineer's Qualifications:
 - a. Engage a Test and Balance Engineer certified by the Associated Air Balance Council (AABC) to perform the testing, adjusting, and balancing (TAB) required under this Section.



- b. At least 6 weeks prior to starting testing and balancing Work, submit the Test and Balance Engineer's qualifications to the Program/Project Manager for approval.
 - 1) Include the names of contractors and facility managers of recent projects on which the Site technician was the lead.

1.06 WARRANTY

A. Special Warranty:

1. National Project Performance Guarantee:

- a. Furnish a guarantee on the appropriate forms from the AABC National Standards for Total System Balance stating that Associated Air Balance Council (AABC) will assist in completing the requirements of the Contract Documents if the Test and Balance Engineer fails to comply with the Contract Documents.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

- 1. Examine system and equipment installations to verify that they are complete; and that the testing, cleaning, adjusting, and commissioning specified in other Sections have been performed.
 - a. Examine the heating, ventilating, and air-conditioning (HVAC) system and equipment installations to verify that the indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed; and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 - b. Examine the heating, ventilating, and air-conditioning (HVAC) equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and controls are functioning and the equipment is ready for operation.
 - c. Examine heat-transfer coils to ensure that piping connections are correct and fins are clean and straight.
 - d. Examine equipment safety interlocks and controls to verify proper installation and operation.



- e. Examine plenum ceilings used for supply air to verify they are airtight.
 - 1) Verify that pipe penetrations and other holes are sealed.
- f. Examine automatic temperature system components to verify the following:
 - 1) Dampers, valves, and other control devices are operated by the intended controller.
 - 2) Dampers and valves are in the position indicated by the controller.
 - 3) The integrity of the dampers allows free and full damper operation, and maintains the tightness of fully closed and fully open positions.
 - 4) Thermostats are located so the adverse effects of sunlight, drafts, and cold walls are avoided.
 - 5) Sensors are located so only the intended conditions are sensed.
 - 6) The sequence of operation for the control modes is in accordance with the requirements specified in the Contract Documents.
 - 7) Controller set points are at the indicated values.
 - 8) Interlocked systems are operating properly.
 - 9) The changeover from heating to cooling mode occurs according to the indicated values.
- 2. Complete system readiness checks, and prepare system readiness reports, to verify the following:
 - a. Permanent electrical power wiring is complete.
 - b. Automatic temperature-control systems are operational.
 - c. Equipment and duct access doors are securely closed.
 - d. Balance, smoke, and fire dampers are open.
 - e. Ceilings are installed in critical areas where air-pattern adjustments are required, and access to balancing devices is provided.
 - f. Windows and doors can be closed so the indicated conditions for system operations can be met.
- 3. Examine systems to identify functional deficiencies that cannot be corrected by adjusting and balancing.

3.02 PREPARATION

- A. Testing, Adjusting, and Balancing (TAB) Plan:
 - 1. At least 6 weeks prior to starting the testing and balance Work for this Contract and after the Test and Balance Engineer has some familiarity with the control system, prepare a preliminary outline of the Testing, Adjusting, and Balancing (TAB) Plan describing the approach contemplated for each system and component, and submit this outline to the Commissioning Authority (CA), the Program/Project Manager, and the controls Subcontractor to solicit their comments.



2. After receiving comments regarding the preliminary outline of the Testing, Adjusting, and Balancing (TAB) Plan, develop a Testing, Adjusting, and Balancing (TAB) Plan that includes, but is not limited to, the following information:
 - a. Certification that Test and Balance Engineer has reviewed Contract Documents and systems with the Program/Project Manager and the Subcontractors to sufficiently understand the design intent of each system.
 - b. An explanation of the intended use of the building control system.
 - 1) The controls Subcontractor must comment on the feasibility of the Testing, Adjusting, and Balancing (TAB) Plan.
 - c. Field checkout sheets and logs listing each piece of equipment to be tested, adjusted, and balanced, and including the data cells to be completed for each.
 - d. A discussion of the notations and markings that will be made on the duct and piping drawings during the testing, adjusting, and balancing (TAB) process.
 - e. Final test report forms to be used.
 - 1) To report test results, use the standard forms from AABC National Standards for Total System Balance.
 - f. The following detailed step-by-step procedures for testing and balance Work for each system:
 - 1) Terminal flow calibration for each terminal type.
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Calculating total flow.
 - 5) Rechecking.
 - 6) Diversity issues.
 - 7) Expected problems and solutions, and similar issues.
 - 8) Discussion of the criteria for using air flow straighteners or relocating flow stations and sensors.
 - 9) Discussion of the criteria for using straighteners or relocating flow stations and sensors on the water side.
 - g. A list of air flow, water flow, sound level, system capacity, and efficiency measurements to be performed; and a description of specific test procedures, parameters, and formulas to be used.
 - h. Details of how total flow will be determined:
 - 1) Air:
 - a) Sum of terminal flows via building automation system (BAS) calibrated readings, or via hood readings of terminals, supply



air (SA) and return air (RA) pitot traverse, and supply air (SA) or return air (RA) flow stations.

2) Water:

- a) Pump curves, circuit setters, flow stations, ultrasonic, and similar items.
- i. Types and identification of measurement instruments to be used, and the most recent calibration date for each instrument.
- j. Specific procedures to ensure, and methods to verify that, both the air side and water side are operating at the lowest possible pressures.
- k. Confirmation that the Test and Balance Engineer understands outside air ventilation criteria under all conditions.
- l. Whether and how minimum requirements for outside air will be verified and set, and at what level such as for the total building, for zones, or similar levels.
- m. Details of how building static and exhaust fan/relief damper capacity will be determined.
- n. Proposed selection points for sound measurements, and sound measurement methods.
- o. Details of methods for making specified coil or other system plant capacity measurements.
- p. Details of testing and balance Work to be done in phases such as by floor, or similar delineations; and of areas to be built out later.
- q. Details regarding specified deferred or seasonal testing and balance Work.
- r. Details of specified false loading of systems to complete testing and balance Work.
- s. Details of exhaust fan balancing and capacity verifications, including required room pressure differentials.
- t. Details of required interstitial cavity differential pressure measurements and calculations.
- u. The plan, including the scope and frequency, for using hand-written field technician logs to record discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests.
- v. The plan, including the scope and frequency, for formal progress reports.
- w. The plan, including the scope, frequency, and distribution for formal deficiency reports.
- 1) Have the testing and balancing field technicians maintain a running log of events and issues.



- 2) Submit handwritten reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests to Commissioning Authority and the Program/Project Manager at least twice a week.
3. Prepare a Testing, Adjusting, and Balancing (TAB) Plan that includes strategies and step-by-step procedures for testing, adjusting, and balancing the mechanical equipment and systems provided under this Contract.
4. Examine the Contract Documents to become familiar with the Contract requirements, and to discover the conditions in the systems' and equipment designs that may preclude proper testing, adjusting, and balancing (TAB) of the systems and equipment.
 - a. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, required by the Contract Documents are installed.
 - 1) Verify that these balancing devices are accessible, there are sufficient quantities of balancing devices for efficient system and equipment operation, and that the balancing devices are located in appropriate locations for effective balancing.
 - b. Examine design data, including heating, ventilating, and air-conditioning (HVAC) system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
 - c. Examine approved submittal data for the heating, ventilating, and air-conditioning (HVAC) systems and equipment.
 - 1) Examine equipment performance data, including fan and pump curves.
 - 2) Relate the performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - a) Calculate system effect factors that reduce the performance ratings of HVAC equipment when it is installed under conditions different from those represented when the equipment was performance tested at the factory.
 - (1) To calculate system effects for air systems, use the tables and charts in Sections 7 through 10 of AMCA 201, or in Sections 5 and 6 of SMACNA HVAC Systems – Duct Design.



- b) Compare this data with the design data and installed conditions.
 - 3) Examine system and equipment test reports.
 - d. Examine the Project Record Documents specified in Section 01780, Closeout Submittals.
- 5. Within 30 days from the Notice-to-Proceed, submit the Testing, Adjusting, and Balancing (TAB) Plan, including a complete set of TAB report forms intended for use on this Contract, to the Program/Project Manager for approval.
- B. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from testing and balancing mechanical equipment.
- C. Demolition/Removal:
 - 1. For installing test probes, cut insulation, ducts, pipes, and equipment cabinets to the minimum extent necessary to allow procedures to be adequately performed.

3.03 REPAIR/RESTORATION

- A. After testing and balancing, close the probe holes and patch the insulation with new materials identical to those removed.
- B. Restore the vapor barrier and finish in accordance with the requirements specified in Section 15080, Mechanical Insulation.

3.04 TESTING, ADJUSTING, AND BALANCING MECHANICAL SYSTEMS

- A. Perform testing, adjusting, and balancing procedures on each system in accordance with the procedures specified in AABC National Standards for Total System Balance, AABC Test and Balance Procedures, and this Section.
- B. Testing, Adjusting, and Balancing (TAB) Field Reports:
 - 1. Observe and record system reactions to changes in conditions.
 - 2. Record default set points if they are different from the values indicated in the Contract Documents.
 - a. Submit set point and parameter changes made, and problems and discrepancies identified, during testing and balance Work which affect the control system setup and operation to the controls Subcontractor in writing.
 - 3. Report deficiencies discovered before and during performance of the testing, adjusting, and balancing (TAB) procedures.



- a. During testing, adjusting, and balancing (TAB), report temperature regulation adjustments required within the automatic temperature-control system.
 4. Testing, Adjusting, and Balancing (TAB) Report Forms:
 - a. To report test results, use the standard forms from AABC National Standards for Total System Balance.
 5. Testing, Adjusting, and Balancing (TAB) Report Certification:
 - a. Have the Test and Balance Engineer certify that he or she has reviewed the field data in order to validate the accuracy of the data; has prepared the testing, adjusting, and balancing (TAB) reports; and has complied both in accordance with the approved Testing, Adjusting, and Balancing (TAB) Plan and the procedures specified and referenced in this Section.
 6. Have the Test and Balance Engineer prepare and certify Testing, Adjusting, and Balancing (TAB) Field Reports on the approved forms, and submit these reports to the Program/Project Manager for information.
- C. Testing and Balancing Air Systems:
 1. Obtain the manufacturer's outlet factors and recommended testing procedures.
 - a. Prepare schematic diagrams of the air systems' "as-built" duct layouts.
 - b. Crosscheck the summation of the required outlet volumes with the required fan volumes.
 2. Locate the start-stop and disconnect switches, electrical interlocks, and motor starters.
 - a. Verify that the motor starters are equipped with properly sized thermal protection.
 - b. Verify that the dampers are set to the proper position to achieve the desired airflow path.
 - c. Verify that there are no airflow blockages.
 - d. Verify that condensate drains are properly connected and functioning.
 - e. Verify that air-handling unit components are properly sealed.
 - f. Verify that the air duct system is proper sealed.
 3. Determine the airflow patterns from the outside-air louvers and dampers and the return-air dampers and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
 - a. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
 4. Constant-Volume Air Systems:



- a. Adjust fans, within the maximum allowable fan speed listed by the fan manufacturer, to deliver the total airflows indicated in the Contract Documents.
 - 1) Determine the actual static pressure as follows:
 - a) Measure the outlet static pressure as far downstream from the fan as practicable but upstream from restrictions in the ducts such as elbows and transitions.
 - (1) Measure the static pressure directly at the fan outlet or through the flexible connection.
 - b) For single-inlet fans, measure the inlet static pressure in the inlet duct as near to the fan as possible, but upstream from the flexible connection and downstream from duct restrictions.
 - 2) Measure the static pressure across each component that makes up the air-handling system.
 - 3) Compare the design data to the installed conditions and determine variations in design static pressures versus actual static pressures.
 - a) Compare the actual system effect factors with the calculated system effect factors to identify where variations occur.
 - 4) Recommend corrective action to align the actual conditions to design conditions.
 - a) Obtain the Program/Project Manager approval before adjusting fan speeds higher or lower than the indicated speed.
 - (1) Adjust pulley sizes, motor sizes, and electrical connections to facilitate fan-speed changes.
 - (2) Do not make fan-speed adjustments that overload the motor.
 - b) Consult equipment manufacturers regarding fan-speed safety factors.
 - 5) To ensure that no overload will occur, modulate dampers and measure fan-motor amperage.
 - a) Determine the maximum required brake horsepower by measuring the amperage in full cooling, full heating, economizer, and other operating modes.
- b. Adjust volume dampers for the main duct, submain ducts, and major branch ducts within the specified tolerances to achieve the airflows indicated in the Contract Documents.
 - 1) Measure the static pressure at a point downstream from the balancing damper, and adjust the volume dampers until the proper static pressure is achieved.



- 2) Continue adjusting submain and branch ducts within the specified tolerances to the airflows indicated in the Contract Documents.
 - 3) After all submain and branch ducts have been adjusted, re-measure each submain and branch duct.
 - c. Determine the static pressure at terminal outlets and inlets without making adjustments.
 - 1) Determine the static pressure at terminal outlets using either a direct-reading hood to measure the pressure, or the outlet manufacturer's written instructions and calculating factors.
 - d. Adjust the terminal outlets and inlets for each space to the airflow values indicated in the Contract Documents within the specified tolerances.
 - 1) Adjust the airflow using volume dampers instead of extractors and the dampers at the air terminals.
 - 2) Adjust each outlet within the same room or space to the indicated airflow within the specified tolerances without generating noise above the levels specified in the Contract Documents.
 5. Have the Test and Balance Engineer prepare and certify test reports for both the fans and the outlets on the approved forms, and submit these Fan and Outlet Testing, Adjusting, and Balancing (TAB) Field Test Reports to the Program/Project Manager for information.

D. Testing Motors:

1. Test motors 1/2 horsepower and larger at the final balanced conditions, and record the following data:
 - a. Motor manufacturer, model number, and serial number.
 - b. Motor horsepower rating.
 - c. Motor revolutions per minute (rpm).
 - d. Efficiency rating.
 - e. Nameplate and measured voltage of each phase.
 - f. Nameplate and measured amperage of each phase.
 - g. Starter thermal-protection-element rating.
2. Have the Test and Balance Engineer prepare and certify test reports for the motors on the approved forms, and submit these Motor Testing, Adjusting, and Balancing (TAB) Field Test Reports to the Program/Project Manager for information.

E. Testing Temperature Controls:

1. Temperature Measurement:
 - a. To prove correctness of the final temperature settings, measure the indoor wet-bulb and dry-bulb temperatures in each separately controlled zone every other hour during 2 successive eight-hour days.



- 1) Measure the indoor wet-bulb and dry-bulb temperatures when the building or zone is occupied.
 - b. Measure the outside-air, wet-bulb and dry-bulb temperatures.
 2. Temperature-Control Verification:
 - a. Verify the transmitter and controller locations, and note conditions that could adversely affect control functions.
 - b. Verify that the temperature controllers have been calibrated and commissioned.
 - c. Record the controller settings, and note variances between the set points and the actual measurements.
 - d. Verify the operation of limiting controllers, including high-temperature and low-temperature controllers.
 - e. Verify the free travel and proper operation of control devices, such as damper and valve operators.
 - f. Verify the proper sequence of operation of the control devices.
 - 1) Note the air pressures and device positions, and correlate them with the airflow and water flow measurements.
 - 2) Note the speed of the response to the input changes.
 - g. Verify the proper interaction of electrically operated switch transducers.
 - h. Verify the proper interaction of interlock and lockout systems.
 - i. Record the voltages of the power supply and controller output.
 - 1) Determine whether the system operates on a grounded or non-grounded power supply.
 - j. Verify the proper operation of electric actuators that require a spring return for proper fail-safe operations.
 3. Have the Test and Balance Engineer prepare and certify test reports for the temperature controls on the approved forms, and submit these Temperature-Control Testing, Adjusting, and Balancing (TAB) Field Test Reports to the Program/Project Manager for information.
- F. To show the final settings, mark equipment and balancing device settings, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, using paint or another suitable permanent identification material.

3.05 CLOSEOUT ACTIVITIES

- A. Final Testing, Adjusting, and Balancing (TAB) Report:
1. Within 2 weeks of the completion of the testing, adjusting, and balancing of the mechanical equipment and systems, prepare a draft Final Testing,



- Adjusting, and Balancing (TAB) Report, and submit a copy to the Commissioning Authority (CA) and the Program/Project Manager.
- a. Include a full explanation of the methodology, assumptions, and results in a clear format, designating uncommon abbreviations and column headings, in the report.
 - b. Follow latest and most rigorous reporting recommendations in AABC National Standards for Total System Balance, NEEB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, or ASHRAE 111 to compile the report.
2. After the equipment and systems have been tested, adjusted, and balanced, prepare a Final Testing, Adjusting, and Balancing (TAB) Report that includes the following information:
- a. Field report data certified by the Test and Balance Engineer.
 - b. Fan curves.
 - c. Manufacturers' test data.
 - d. Field test reports prepared by the system and equipment installers.
 - e. Other information relative to equipment performance.
 - f. Include drawings marked to indicate where traverse and other critical measurements were taken, and cross referenced to locations in the Final Testing, Adjusting, and Balancing (TAB) Report.
3. Do not include Shop Drawings and Product Data in the Final Testing, Adjusting, and Balancing (TAB) Report.
4. Report Format:
- a. Prepare a typewritten, or computer printer-generated, report using a letter-quality font on standard bond paper that includes the following items:
 - 1) A title page.
 - 2) The name and address of the Test and Balance Technician or Test and Balance Engineer.
 - 3) The Project and Contract names.
 - 4) The Project and Contract locations.
 - 5) The Program/Project Manager's name and address.
 - 6) The Design Professional's name and address.
 - 7) The Contractor's name and address.
 - 8) The report date.
 - 9) A certification sheet in the front of the binder signed and sealed by the certified Test and Balance Engineer to certify the report.
 - 10) A Table of Contents having the total number of pages defined for each section of the report.
 - a) Number each page in the report.
 - 11) A summary of the report contents, including the following:



- a) Indicated performance versus final performance.
 - b) Notable characteristics of the systems.
 - c) A description of the system operation sequence if it varies from operation sequence in the Contract Documents.
- 12) A list of the instruments used for performing the testing, adjusting, and balancing procedures, and proof of proper calibration of the instruments.
- 13) Testing, Adjusting, and Balancing (TAB) Report Forms completed with form titles and entries.
- 14) System Diagrams:
 - a) Include schematic layouts of the air distribution systems.
 - b) Depict each air distribution system using a single-line diagram that includes the following information:
 - (1) Quantities of outside, supply, return, and exhaust airflows.
 - (2) Duct, outlet, and inlet sizes.
 - (3) Balancing stations.
 - (4) The position of balancing devices.
- 15) Nomenclature sheets for each item of equipment.
- 16) Data for terminal units, including the manufacturer, type, size, and fittings.
- 17) Notes to explain why certain final data in the body of reports varies from indicated values.
- 18) Test conditions for the fan and pump performance forms, including the following:
 - a) Settings for the outside-air dampers, return-air dampers, and exhaust-air dampers.
 - b) Condition of filters.
 - c) Cooling coil wet-bulb and dry-bulb conditions.
 - d) Settings for the fan drive.
 - e) Settings for the supply-air, static-pressure controller.
 - f) Operating conditions of other systems that affect performance.
- 5. Submit the Final Testing, Adjusting, and Balancing (TAB) Report, having details as in the draft, to the Program/Project Manager and Commissioning Authority (CA) for information.
 - a. Include gathered data requested by the Commissioning Authority, but not furnished in draft reports.

B. Training:

- 1. After the Test and Balance Engineer has completed the testing and balancing Work, have him or her furnish 24 hours of instruction for the Owner's staff, to include the following topics:



- a. A review of the Final Testing, Adjusting, and Balancing (TAB) Report to explain the layout and meanings of each data type.
- b. A discussion of outstanding deficient items in the control, ducting, or design that may affect proper delivery of air or water.
- c. Identification and discussion of terminal units, duct runs, diffusers, coils, fans, and pumps that are close to or are not meeting specified design capacity.
- d. A discussion of temporary settings and steps to finalize areas which are not completed.
- e. Other salient information that may be useful for facility operations, relative to testing and balance Work.
- f.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 15995

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for commissioning the mechanical systems listed in Section 01810, Commissioning.
 - 2. Requirements for demonstrating the operation of the mechanical systems listed in Section 01810, Commissioning.
 - 3. Requirements for providing training to the Owner's personnel for the mechanical systems listed in Section 01810, Commissioning.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 15950 - Testing, Adjusting, and Balancing.
 - 7. Section 16080 - Electrical Testing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. BAS: Building Automation System.
 - 2. CA: Commissioning Authority.
 - 3. CFM: Cubic feet per minute.
 - 4. DB: Dry bulb.
 - 5. DDC: Direct digital control.
 - 6. DP: Double pole.
 - 7. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 8. OSA: Outside air.
 - 9. P/T: Pressure transmitter.
 - 10. RA: Return air.
 - 11. SA: Supply air.
 - 12. SAT: Supply air temperature.
- B. Definitions:
 - 1. Calculated Point: A virtual point generated by calculations using other point values.



2. Commissioning: A systematic process to ensure that the Phoenix Sky Harbor International Airport's building systems perform interactively according to the design intent and operational needs of the Owner.
 - a. The commissioning process encompasses and coordinates the system documentation, equipment startup, control system calibration, testing and balancing, performance testing, and training.
3. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
 - a. The Commissioning Authority (CA) is not otherwise associated with the Design Consultant or the Contractor.
 - b. The Commissioning Authority (CA) directs and coordinates the day-to-day commissioning activities without assuming oversight responsibilities.
 - c. The Commissioning Authority (CA) reports directly to the Program/Project Manager.
4. Commissioning Plan: An overall plan, developed before or after award of the Contract, that provides the structure, schedule, and coordination planning for the commissioning process.
5. Commissioning Team: A group of stakeholders that includes the following members who work together to fulfill contractual commissioning responsibilities under the Contract:
 - a. The Commissioning Authority (CA).
 - b. The Program/Project Manager.
 - c. The Facilities Manager (FM).
 - d. The Contractor.
 - e. The Contractor's Subcontractors whose equipment and systems will be commissioned, and who typically include the plumbing, HVAC, and fire suppression Subcontractors; the electrical and communications Subcontractors, the HVAC test and balance Subcontractor, the Building Automation System (BAS) Subcontractor, and other specialty system Subcontractors.
 - f. The Design Consultant.
6. Control Point or Set Point: A point that controls equipment, and can have its set point changed, including points for outside air (OSA), supply air temperature (SAT), and similar items.
7. Intermediate Point: A point whose value is used to make a calculation, which then controls equipment; for example, space temperatures that are averaged to a virtual point to control reset.
8. Monitoring Point: A point that does not control or contribute to the control of equipment, but that is used for operation, maintenance, or performance verification.

C. Reference Standards:

1. Associated Air Balance Council (AABC):



- a. AABC National Standards for Total System Balance.
2. AABC Commissioning Group (AGC):
 - a. AGC Commissioning Guideline.
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ASHRAE Guideline 1.1-2008 - HVAC&R Technical Requirements for the Commissioning Process (*Supersedes ASHRAE Guideline 1-1996*).
 - b. ANSI/ASHRAE 111 – Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
4. National Environmental Balancing Bureau (NEBB):
 - a. NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Commissioning requires participation not only of the Contractor, but also of the mechanical and mechanical controls Subcontractors and Suppliers, to ensure that systems are operating in a manner consistent with the requirements specified in the Contract Documents.
 - a. General commissioning and coordination requirements are specified in Section 01810, Commissioning.
 - 1) Familiarize the mechanical Subcontractors with the requirements specified in Section 01810, Commissioning, and the Commissioning Plan issued by the Commissioning Authority.
 - 2) In each purchase order or subcontract written, include the requirements for submittal data, commissioning documentation, Operation and Maintenance data, and demonstration and training services required for performing commissioning activities.
 - b. Coordinate the commissioning activities with the testing, adjusting, and balancing of mechanical systems and equipment performed by the Test and Balance Engineer under Section 15950, Testing, Adjusting, and Balancing.
 - 1) Have the Commissioning Authority (CA) complete and approve the required pre-functional checklists, calibrations, startup, and selected functional tests of the systems for each given area prior to performing testing and balance activities.
2. Take responsibility for coordinating and scheduling the training specified in Section 01770, Closeout Procedures, and Section 01810, Commissioning; and ultimately for ensuring that the training is completed in accordance with the requirements specified.

B. Pre-Installation Meetings:

1. Commissioning Scoping Meeting:



- a. Within 60 days of commencement of construction, the Commissioning Authority (CA) will schedule, plan, and conduct a Commissioning Scoping Meeting with the entire commissioning team for this Contract in attendance.
 - b. Information gathered from this meeting will allow the Commissioning Authority (CA) to update the Commissioning Plan to its "final" version, which will be distributed to all parties in attendance.
 2. Miscellaneous Meetings:
 - a. Other meetings besides the Commissioning Scoping Meeting will be planned and conducted by the Commissioning Authority (CA) as construction progresses.
 - 1) These miscellaneous meetings will cover coordination, deficiency resolution, and planning issues with particular Subcontractors.
 - 2) The Commissioning Authority (CA) will plan these meetings, and will minimize unnecessary time being spent by Subcontractors.
 - 3) These miscellaneous meetings may be held monthly, until the final 3 months of construction when they may be held as frequently as one per week.
 3. Meeting Minutes:
 - a. The Commissioning Authority (CA) will prepare and distribute meeting minutes to all parties in attendance at commissioning meetings.
- C. Scheduling:
 1. Prepare a preliminary schedule for the start and completion of mechanical pipe and duct system testing, flushing and cleaning, mechanical equipment startup, and testing and balancing for use by the Commissioning Authority (CA).
 - a. Submit this preliminary schedule, and schedule updates as appropriate, for this mechanical Work to the Program/Project Manager and the Commissioning Authority (CA) for approval.

1.04 SUBMITTALS

- A. Submit Product Data, Shop Drawing, and Operation and Maintenance Manual submittals of equipment to be commissioned to the Commissioning Authority as specified in Section 01810, Commissioning.
- B. Prior to submitting normal Operation and Maintenance Manual submittals, submit additional requested documentation to the Commissioning Authority to enable development of the startup and functional testing procedures.
 1. Submittal documentation includes, but is not limited to, detailed manufacturer installation and startup, operating, troubleshooting, and maintenance procedures; full details of Owner-contracted tests; fan and pump curves; full factory testing reports, if any; and warranty information, including clearly defined actions that are the responsibility of the Owner in order to keep warranties in force.



- a. Include installation, startup, and checkout materials shipped with the equipment provided, and field checkout forms to be used by factory or field technicians.
 - b. The Commissioning Authority may request further documentation necessary for the commissioning process.
2. Requests for data may be made prior to, concurrent with, or following normal submittals.

C. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Shop Drawings:
 - 1) Sequences of Operation drawings.
 - 2) Control drawings.
 - b. Certificates:
 - 1) Certification that the control system programming is complete and in accordance with the Contract Documents.
 - c. Delegated Design Submittals:
 - 1) Preliminary schedule, and schedule updates, for mechanical Work.
 - d. Special Procedure Submittals:
 - 1) Product Data, Shop Drawing, and Operation and Maintenance Manual submittals of equipment to be commissioned.
 - 2) Additional documentation requested by the Commissioning Authority.

D. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Controls training manuals.
 - b. Record Documentation:
 - 1) As-built drawings showing the commissioned mechanical equipment and systems.

1.05 WARRANTY

A. Manufacturer Warranties:

1. Determine the specific requirements necessary to maintain the validity of the warranties for mechanical equipment and systems to be commissioned by contacting and coordinating activities with the manufacturers of the mechanical equipment and systems to be commissioned and those responsible for actions required to maintain the warranties in effect.



B. Warranty Period:

1. During the warranty periods for the mechanical equipment and systems to be commissioned, correct deficiencies and make necessary adjustments to the mechanical equipment and systems, Operation and Maintenance Manuals, and Record Documentation.
 - a. Address applicable issues identified during seasonal testing.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 COMMISSIONING MECHANICAL EQUIPMENT AND SYSTEMS

A. Mechanical and Mechanical Controls Subcontractors Commissioning Responsibilities:

1. The mechanical and mechanical controls Subcontractors, or the Contractor if there are no mechanical and/or mechanical controls Subcontractors, are required to execute the commissioning responsibilities assigned to them by the Contract Documents, including, but not limited to, the following:
 - a. Furnishing an itemized cost for providing the services to commission mechanical systems for inclusion in the in the Guaranteed Maximum Price (GMP).
 - b. Attending the commissioning scoping meeting and other meetings necessary to facilitate the commissioning process for this Contract.
 - c. Supporting the Commissioning Authority (CA) through all phases of the commissioning process.
 - 1) The mechanical and mechanical controls Subcontractors are responsible for working with the Commissioning Authority according to the protocols established in the Commissioning Plan.
 - 2) The mechanical and mechanical controls Subcontractors are responsible for furnishing sufficient notice to the Program/Project Manager, the Owner, and the Commissioning Authority (CA) regarding the completion schedule for the pre-functional checklists and the startup of the mechanical and mechanical controls equipment and systems.
 - a) Furnish notice ahead of the time when pipe and duct system testing, flushing, cleaning, and testing and balancing, and the startup of each piece of equipment will occur.
 - b) Take responsibility for notifying the Program/Project Manager, the Owner, and the Commissioning Authority (CA) when commissioning activities not yet performed or not yet scheduled will delay construction.



- c) Be proactive to ensure that commissioning processes are executed, and that the Commissioning Authority (CA) has the scheduling information needed to efficiently execute the commissioning process.
- d. Supporting the Test and Balance Engineer by helping to place heating, ventilating, and air-conditioning (HVAC) equipment and systems into operation, and keeping the equipment and systems in continuous operation as required during each work day the testing and balancing and commissioning is performed.
 - 1) To allow air measurements and air balancing, provide test holes in ducts and plenums where directed by the Test and Balance Engineer, and provide approved plugs.
 - 2) For testing and balancing, and for commissioning tests, provide temperature and pressure taps in accordance with the requirements specified in the Contract Documents.
 - 3) Install a pressure transmitter (P/T) plug at each water sensor that is an input point to the control system.
 - 4) Beyond the control points necessary to execute the documented control sequences, provide the monitoring, control, and virtual points specified in Section 15950, Testing, Adjusting, and Balancing.
- e. Written Work Products:
 - 1) The mechanical and mechanical controls Subcontractors are responsible for furnishing the written work products specified in Section 01810, Commissioning, including the procedures to be executed as part of initial checkout and other input for developing the Startup Plans, and executed (filled in and signed) initial checkout, startup, and pre-functional checklists.
 - a) Prior to the functional performance testing to be performed in accordance with the process specified in Section 01810, Commissioning, prepare a written plan that indicates the step-by-step procedures required to test, check, and adjust the control system; and that includes the following information for each type of equipment controlled by automatic controls:
 - (1) System name.
 - (2) A list of devices.
 - (3) Step-by-step procedures for testing each controller after installation, including the following information:
 - (a) The process for verifying hardware and wiring have been properly installed.
 - (b) The process for downloading programs to local controllers, and for verifying they are addressed correctly.
 - (c) The process for performing operational checks of each controlled component.



- (d) The plan and process for calibrating valve and damper actuators and sensors.
 - (e) A description of expected field adjustments for transmitters, controllers, and control actuators in the event control responses fall outside expected values.
- (4) A copy of the log and field checkout sheets to document the process.
 - (a) Include a place in the log for the initial and final values read during the calibration of each point, and clearly indicate when the sensor or controller has passed and is operating within the Contract parameters.
 - (5) A description of the instrumentation required for testing.
- b) Coordinate with the Commissioning Authority (CA) and Test and Balance Engineer to determine which systems must be tested, and which tests must be performed on them, prior to using the control system for the testing and balancing Work.
- 2) If the Specifications, control drawings, or equipment documentation furnish insufficient information to allow detailed testing procedures to be written, then with assistance from the Program/Project Manager furnish clarification of the operation and control of the equipment to be commissioned to the Commissioning Authority (CA).
- 3) Using the manufacturer's startup procedures and pre-functional checklists from the Commissioning Authority, develop initial checkout and full Startup Plans for mechanical equipment and systems to be commissioned in accordance with the requirements specified in Section 01810, Commissioning.
 - a) Submit the initial checkout and full Startup Plans to the Commissioning Authority for review and approval prior to startup of the equipment or system.
- 4) Provide assistance to the Commissioning Authority for preparing functional performance test procedures.
 - a) Review the test procedures to ensure their feasibility, safety, and protection of equipment; and furnish in writing the necessary alarm limits to be used during the tests.
- f. Furnishing the mechanical and mechanical controls testing equipment required to perform the commissioning procedures indicated in the Contract Documents.
- g. Executing the tasks listed on the approved pre-functional checklists and performing the startup tests.
 - 1) Provide skilled technicians to execute the starting of equipment and to execute functional performance tests.
 - a) Ensure that the technicians are available and present during agreed upon schedules, and for a sufficient time to complete the necessary tests, adjustments, and problem solving.



- 2) Prior to performing the functional testing for each piece of equipment or system but after the checkout of each controlled device, equipment, and system has been completed, submit a signed and dated certification to Commissioning Authority and Program/Project Manager certifying that the control system programming is complete and in accordance with the Contract Documents, except for functional testing requirements.
 - h. Under the direction of the Commissioning Authority (CA), performing the functional performance tests (FPT) and executing seasonal or deferred functional performance testing, witnessed by the Commissioning Authority, in accordance with the requirements specified in the Contract Documents.
 - 1) Provide skilled technicians to perform the functional performance testing under the direction of the Commissioning Authority for the equipment specified in Section 15950, Testing, Adjusting, and Balancing, and Section 01810, Commissioning.
 - 2) Assist the Commissioning Authority in interpreting monitoring data as necessary.
 - 3) Execute the control system trend logs specified in Section 15950, Testing, Adjusting, and Balancing, and Section 16080, Electrical Testing.
 - i. Correcting deficiencies, meaning differences between the specified and observed performance as interpreted by the Commissioning Authority, in the tested equipment and systems; and retesting the equipment and systems after corrections have been made.
- B. Mechanical Controls Subcontractors Commissioning Responsibilities:
 1. The mechanical controls Suppliers and vendors are required to execute the commissioning responsibilities assigned to them by the Contract Documents, including, but not limited to, the following:
 - a. Furnishing requested Submittal data, including detailed startup procedures, and specifying specific responsibilities of the Owner required for maintaining the equipment warranties in force.
 - 1) Sequences of Operation:
 - a) Submit Sequences of Operation drawings to the Program/Project Manager for approval that include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in specifications, and include at a minimum the following information:
 - (1) An overview narrative of the system, generally describing the system=s purpose, components, and function.
 - (2) Interactions and interlocks with other systems.
 - (3) A detailed delineation of control between packaged controls and the Building Automation System (BAS) that



- lists what points the BAS only monitors, and what BAS points are control points and are adjustable.
- (4) Written sequences of control for packaged controlled equipment.
 - (a) Manufacturer's stock sequences may be included, but normally require additional narrative.
 - (5) Startup sequences.
 - (6) Warm up mode sequences.
 - (7) Normal operating mode sequences.
 - (8) Unoccupied mode sequences.
 - (9) Shutdown sequences.
 - (10) Capacity control sequences and equipment staging.
 - (11) Temperature and pressure control:
 - (a) Include setbacks, setups, resets, and similar items.
 - (12) Detailed sequences for control strategies, including, but not limited to, economizer control, optimum start/stop, staging, optimization, demand limiting, and similar items.
 - (13) Effects of power equipment failure, and standby component functions.
 - (14) Sequences for alarms and emergency shut downs.
 - (15) Seasonal operational differences and recommendations.
 - (16) Initial and recommended values for adjustable settings, set points and parameters typically set or adjusted by operating staff and other control settings or fixed values, delays, and similar items that will be useful during testing and operation of equipment.
 - (17) Schedules, if they are known.
- b) To facilitate referencing in testing procedures, write sequences in small statements, each having a number for reference.
 - (1) For a given system, do not repeat numbers for different sequence sections, unless the sections are numbered.
- 2) Control Drawings:
- a) Submit control drawings to the Program/Project Manager for approval that include at a minimum the following information:
 - (1) A key to abbreviations used.
 - (2) Graphic schematic depictions of the systems and each component.
 - (3) Schematics that include the system and component layout of equipment that the control system monitors, enables, or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - b) Provide a full points list, and keep the Commissioning Authority informed of changes in the list during programming and setup.



- c) Include at a minimum the following information for each point:
 - (1) Controlled system.
 - (2) Point abbreviation.
 - (3) Point description:
 - (4) Dry bulb (DB) temperature, airflow, and similar information.
 - (5) Display unit.
 - (6) Control point or set point (Yes/No):
 - (7) Monitoring point (Yes/No):
 - (8) Intermediate point (Yes/No):
 - (9) Calculated point (Yes/No):
 - b. Furnishing assistance during equipment testing.
 - c. Furnishing costs to include in the Guaranteed Maximum Price (GMP) for special tools and instruments only available from the equipment Suppliers or vendors, that are specific to a piece of equipment, as required by the Specifications, and required for testing the equipment according to the Contract Documents, except for stand-alone data logging equipment that may be used by the Commissioning Authority (CA).
 - d. Furnishing information requested by the Commissioning Authority (CA) regarding the sequences of operation and testing procedures for equipment.
 - e. Reviewing and approving test procedures for equipment installed by factory representatives.
- C. Mechanical Equipment and Systems Supplier's Commissioning Responsibilities:
 - 1. The mechanical Suppliers and vendors are required to execute the commissioning responsibilities assigned to them by the Contract Documents, including, but not limited to, the following:
 - a. Furnishing requested Submittal data, including detailed startup procedures, and specifying specific responsibilities of the Owner required for maintaining the equipment warranties in force.
 - b. Furnishing assistance during equipment testing.
 - c. Furnishing costs to include in the Guaranteed Maximum Price (GMP) for special tools and instruments only available from the equipment Suppliers or vendors, that are specific to a piece of equipment, as required by the Specifications, and required for testing the equipment according to the Contract Documents, except for stand-alone data logging equipment that may be used by the Commissioning Authority (CA).
 - d. Furnishing information requested by the Commissioning Authority (CA) regarding the sequences of operation and testing procedures for equipment.
 - e. Reviewing and approving test procedures for equipment installed by factory representatives.



3.02 SYSTEM STARTUP

- A. Prior to system startup, complete the mechanical systems and sub-systems so the systems and sub-systems are fully functional, and meet the performance and design requirements of the Contract Documents.
 - 1. Commissioning procedures and functional testing do not relieve or lessen this responsibility, or shift this responsibility in whole or in part to the Commissioning Authority or the Owner.
 - 2. Address current punch list items before performing functional testing.
 - a. Complete air and water testing and balancing, and remedy discrepancies and problems discovered, before performing functional testing of air-related or water-related electrical systems.
 - 3. Test, adjust, and balance heating, ventilating, and air-conditioning (HVAC) systems in accordance with the requirements specified in Section 15950, Testing, Adjusting and Balancing.
 - a. Conduct functional performance tests and checks on the original testing and balancing as specified for testing and balancing in Section 15950, Testing, Adjusting, and Balancing.
- B. Initial Checkout Process and Startup:
 - 1. The mechanical Subcontractors are responsible for following the startup and initial checkout procedures specified in Section 01810, Commissioning, for mechanical equipment and systems, except for the building automation control system, provided under this Contract.
 - a. During initial checkout process and startup, execute and document the mechanical-related portions of the pre-functional checklists provided by the Commissioning Authority for commissioned equipment and systems.
 - b. Perform and clearly document completed startup and system operational checkout procedures, and submit a copy to the Commissioning Authority.
- C. Functional Testing:
 - 1. A complete list of systems to be commissioned, and a description of the process is specified in Section 01810, Commissioning.
 - a. Have the Commissioning Authority (CA) at a minimum perform the startup and checkout activities listed in Section 01810, Commissioning, for the chillers; pumps; cooling towers; boilers; piping systems; ductwork; variable frequency drives; air handlers; packaged air conditioning and heat pumps; air terminal units; unit heaters; heat exchangers; computer room units; fume hoods; lab room pressures; specialty fans; testing, adjusting, and balancing work; chemical treatment systems; the building automation system (BAS); fire and smoke dampers; indoor air quality; equipment sound control; equipment vibration control; egress pressurization, service water



- heaters; service water booster pumps; refrigeration systems; and medical gas systems work pertinent to the Work of this Section.
- b. Specific details of the required functional performance tests are specified in Section 01810, Commissioning; Section 15950, Testing, Adjusting, and Balancing; and in other mechanical Sections.
- c. Specific details regarding non-conformance issues relating to pre-functional checklists and tests are specified in Section 01810, Commissioning.
- 2. Begin functional testing of each mechanical equipment item or system when the equipment item or system is completed.
 - a. At the discretion of the Commissioning Authority (CA) and the Program/Project Manager, functional testing may proceed prior to completion of the system or sub-systems.
 - b. Beginning testing of a system before it is completed does not relieve the Contractor from fully completing the system, or executing pre-functional checklists, as early as possible.
 - c. Specific details regarding deferred testing are specified in Section 01810, Commissioning.

3.03 CLOSEOUT ACTIVITIES

- A. The Commissioning Authority is responsible for overseeing and approving the content and adequacy of the training provided to the Owner's personnel for commissioned mechanical equipment and systems.
- B. Mechanical Subcontractors:
 - 1. The mechanical Subcontractors are responsible for performing the following training-related functions after the functional testing is complete, unless otherwise approved by the Owner in writing:
 - a. For each major piece of equipment, engage an appropriate expert and qualified trainer to furnish the instruction for the Owner's operating staff and demonstrate the equipment as specified.
 - 1) The trainer may be the startup technician for the piece of equipment, the installing Subcontractor, or a trade or manufacturer's representative.
 - 2) The trainer must possess practical building operating expertise and in-depth knowledge of the specific piece of equipment's modes of operation.
 - 3) More than 1 trainer may be required to demonstrate or furnish training for a piece of equipment.
 - b. At least 2 weeks before the training and demonstration are scheduled to occur, submit an outline describing the training to be furnished as specified in Section 01810, Commissioning.
 - c. For each mechanical system, subsystem, or piece of equipment to be commissioned, provide the Owner's designated personnel with a comprehensive orientation and a training session, or training sessions,



designed to furnish an understanding of the systems and their operation and maintenance as specified in Section 01770, Closeout Procedures.

- 1) Begin the training with classroom sessions, if necessary, followed by hands-on training on each piece of equipment or system designed to illustrate the equipment's or system's various modes of operation, including startup, shutdown, fire or smoke alarm, power failure, and similar modes.

C. Controls Subcontractors:

1. The controls Subcontractors are responsible for training designated Owner personnel to clearly and completely understand the capabilities of facility control system.
 - a. The Program/Project Manager will indicate the number of Owner's personnel who will attend the training.
 - 1) If no notice of the number of attendees is provided, provide materials and training for a minimum of 4 people for each session.
2. Unless otherwise approved by the Program/Project Manager in writing, the controls Subcontractors are responsible for performing the following training-related functions after the functional testing is complete:
 - a. Besides the controls training sessions, the controls Subcontractor must attend other training sessions when requested to discuss the interaction of the controls systems as they relate to the equipment being discussed in the other training sessions.
 - b. At least 4 weeks before the training is planned to occur, submit a draft training plan to the Commissioning Authority (CA) in accordance with requirements specified in Section 01770, Closeout Procedures and Section 01810, Commissioning.
- c. Controls Instructors:
 - 1) Employ controls instructors that are knowledgeable of the system and its use in buildings.
 - 2) For onsite sessions, use the most qualified controls instructors.
 - 3) Prior to scheduling training, submit the controls instructors' resumes to the Program/Project Manager for approval of the instructor.
- d. Tailor the training sessions to the needs and skill-level of the trainees.
- e. Training Manuals:
 - 1) For each attendee, furnish the standard operating manual for the system and special training manuals approved by the Commissioning Authority (CA).
 - a) Furnish manuals that include a detailed description of the subject matter for each session.
 - (1) Include the applicable portion of the Operation and Maintenance Manuals for the items for which training is being provided.



- (2) Include copies of all hand-outs, slides, overheads, audiovisual presentations, and similar materials that are not included in the Operation & Maintenance Manuals.
- b) Furnish manuals that include control sequences and a definitions section that fully describes relevant words used in the manuals and in the software displays.
- c) Furnish 3 extra copies of each training manual for inclusion with the operation and maintenance data for the item.
- f. Demonstrate the use of the system technical manual, and furnish 3 additional copies with the Operation and Maintenance Manual submittals.
- g. Furnish 3 separate training sessions as follows:
 - 1) Training Session I - Control System:
 - a) Furnish 8 hours of actual training.
 - b) The training may be held onsite, or in the Supplier's facility. If the training is held offsite, the training may occur prior to final completion of the system's installation.
 - c) Upon completion of the training, each student must be capable of performing elementary operations and of describing the general hardware architecture and functionality of the system using appropriate documentation.
 - 2) Training Session II - Building Systems:
 - a) Furnish 8 hours of actual hands-on training.
 - b) The training must be held onsite after the commissioning of the system has been completed.
 - c) Include instruction on the specific hardware configuration of installed systems in the building, and specific instruction for operating the total system installed, including HVAC systems, lighting controls, and interfaces with security and communication systems.
 - d) Include instruction on security levels, alarms, system startup, shutdown, power outage and restart routines, changing set points, alarms and other typical changed parameter, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy saving strategies and set points that, if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, and similar parameters.
 - e) Include instruction on trending and monitoring features such as values, change of state, totalization, and similar items; and include setting up, executing, downloading, viewing both tabular and graphic features, and printing trends.
 - (1) Have trainees actually set-up trends while the trainer is present.



- f) Include instruction on using remote access to the system via phone lines or networks.
 - g) Include instruction on using a keypad or plug-in laptop computer at the zone level.
 - h) Include instruction on setting up and changing an air terminal unit controller.
 - i) Include instruction on graphics generation.
 - j) Include instruction on point database entry and modifications.
 - k) When applicable, include instruction on understanding direct digital control (DDC) field panel operating programming.
 - l) Discuss every screen, allowing time for questions.
 - 3) Training Session III – Follow-up Training:
 - a) Furnish 8 hours of actual training.
 - b) The training must be held onsite 6 months after occupancy.
 - c) Structure the session to address specific topics that trainees need to discuss, and to answer questions concerning operation of the control system.
- D. Demonstration:
 - 1. Engage the mechanical Subcontractor to fully explain and demonstrate the operation, function, and overrides of local packaged controls not controlled by the central control system to the Owner's designated personnel.
 - a. During the demonstration, if the system fails to perform in accordance with the requirements of the Operation and Maintenance Manual or the sequence of operations, repair or adjust the system as necessary, and repeat the demonstration.
- E. Training of Owner Personnel:
 - 1. Duration of Training:
 - a. Furnish training lasting as long as specified in Section 01770, Closeout Procedures.
 - 2. Classroom Sessions:
 - a. Design training sessions to follow the Table of Contents of the Operation and Maintenance Manuals for the subject equipment, and whenever possible illustrate the use of the Operation and Maintenance Manuals for reference.
 - 1) Use the format and training agenda included in ASHRAE Guideline 1.1-2008.
 - 2) Use overhead projections, slides, video/audio-taped material, as appropriate, in classroom sessions.
 - 3) Refer to the printed installation, operation, and maintenance instruction material included in the Operation and Maintenance Manual for the equipment or system.
 - 4) Review the written operation and maintenance instructions, emphasizing safe and proper operating requirements,



- preventative maintenance, special tools needed, and spare parts inventory suggestions.
- 5) Teach students the startup, shutdown, seasonal changeover, and emergency procedures as applicable, and operation of the equipment or system in all possible modes.
- 6) Discuss relevant health and safety issues and concerns.
- 7) Discuss warranties and guarantees.
- 8) Describe common troubleshooting problems and solutions.
- 9) Discuss peculiarities of the equipment installation or operation.
- 10) Discuss the explanatory information included in the Operation and Maintenance Manuals, and the location of plans and manuals in the facility.
- 3. Hands-On Training
 - a. Furnish hands-on training that includes startup and operation in all modes, including, but not limited to, manual operation, shut-down, and emergency operation procedures, if any.
 - b. Furnish hands-on maintenance training for each piece of equipment.
- F. Record Documentation
 - 1. During construction, prepare and maintain as-built red-line drawings on copies of the Contract Drawings, and prepare final computer-generated as-built drawings to be used as coordination drawings.
 - a. List and clearly identify the locations of static and differential pressure sensors (air, water, and building pressure) on as-built duct and piping drawings.
 - b. List and clearly identify the locations of the air-flow stations on the record drawings.
 - 2. Update the as-built drawings after completion of the commissioning activities, excluding the deferred functional testing.
 - 3. Submit the final computer-generated as-built drawings showing the commissioned mechanical equipment and systems to the Program/Project Manager.

3.04 MAINTENANCE

- A. Operation and Maintenance Manuals:
 - 1. Prepare Operation and Maintenance Manuals in accordance with the requirements specified in the Contract Documents.
 - a. The mechanical Subcontractors, controls Subcontractors, and equipment Suppliers are responsible for compiling and preparing documentation for the mechanical equipment and systems and controls provided under this Contract for inclusion in the Operation and Maintenance Manuals.
 - 1) Prior to training the Owner's personnel, the mechanical Subcontractors, controls Subcontractors, and equipment Suppliers are responsible for furnishing documentation to the



Contractor for inclusion in the Operation and Maintenance Manuals in accordance with requirements of Section 01780, Closeout Submittals.

- b. In addition to documentation specified elsewhere in the Contract Documents, the controls Subcontractor must compile and organize, at a minimum, the following additional data for the control system:
 - 1) In binders separate from the Operation and Maintenance Manuals, 3 copies of the controls training manuals.
 - 2) In the Operation and Maintenance Manuals, include the following additional information:
 - a) Specific instructions on how to perform and apply functions, modes, and similar features mentioned in the controls training sections of this Section, and other features of the system.
 - (1) Include step-by-step instructions.
 - (2) Include indexes and a clear table of contents.
 - (3) Include a detailed technical manual for programming and customizing control loops and algorithms.
 - b) A full set of as-built control drawings.
 - c) A full as-built sequence of operations for each piece of equipment.
 - d) A full points list.
 - (1) In addition to the updated points list required in the original submittals, include a listing of rooms having the following information for each room:
 - (a) Floor.
 - (b) Room number.
 - (c) Room name.
 - (d) Air handler unit identification.
 - (e) Reference drawing number.
 - (f) Air terminal unit tag identification.
 - (g) Heating and/or cooling valve tag identification.
 - (h) Minimum cubic feet per minute (cfm).
 - (i) Maximum cubic feet per minute (cfm).
 - e) A full printout of schedules and set points after testing and acceptance of the system has been completed.
 - f) A full printout of the as-built software program.
 - g) An electronic copy of the entire program for this facility on a compact disk.
 - h) An as-built floor plan and mechanical drawings having system sensors and thermostats shown complete with control system designations.
 - i) Maintenance instructions, including sensor calibration requirements and methods, categorized by sensor type and other similar designations.



- j) Control equipment component submittals, parts lists, and similar information.
- k) Warranty requirements.
- l) Copies of checkout tests and calibrations performed by the Contractor, not including commissioning tests.
- 3) Furnish field checkout sheets and trend logs to the Commissioning Authority (CA) for inclusion in the Commissioning Record Book.
 - a) Insert the data in manuals consisting of labeled 3-ring binders with indexed tabs that organize and subdivide the data in the following order by using permanently labeled tabs:
 - (1) Sequences of operation.
 - (2) Control drawings.
 - (3) Points lists.
 - (4) Controller/module data.
 - (5) Thermostats and timers.
 - (6) Sensors and double pole (DP) switches.
 - (7) Valves and valve actuators.
 - (8) Dampers and damper actuators.
 - (9) Program setups consisting of software program printouts.
- 4) Submit the controls training manuals to the Program/Project Manager and the Commissioning Authority (CA) for review.
- 2. Submit a copy of the Operation and Maintenance Manuals and submittals for the mechanical equipment and systems and controls to be commissioned, as specified in the Contract Documents, to the Commissioning Authority for review.
 - a. Review of commissioning related sections of the Operation and Maintenance Manuals will be completed by both the Program/Project Manager and the Commissioning Authority (CA).
- 3. The mechanical and controls Subcontractors are responsible for clarifying and updating the control drawings and sequences of operation originally furnished to the as-built conditions.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following basic electrical materials and methods:
 - a. Electrical equipment coordination and installation.
 - b. Sleeves for raceways and cables.
 - c. Sleeve seals.
 - d. Grout.
 - e. Common electrical installation requirements.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01732 - Cutting and Patching.
 - 3. Section 01736 - Selective Demolition.
 - 4. Section 07850 - Through Penetration Firestopping Systems.
 - 5. Section 07920 - Joint Sealants.
 - 6. Section 08311 - Access Doors and Frames.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 3. NBR: Acrylonitrile-butadiene rubber.
- B. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM C 138/C 138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 - c. ASTM C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - d. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - e. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 2. City of Phoenix (COP):



- a. Phoenix Building Construction Code and Amendments.
- 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 4. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practices for Good Workmanship in Electrical Construction

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
- 2. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.
- 3. Coordinate the arrangement, mounting, and support of electrical equipment to achieve the following:
 - a. To allow maximum possible headroom, unless specific mounting heights that reduce headroom are indicated.
 - b. To provide for ease of disconnecting the equipment, with minimum interference to other installations.
 - c. To allow right of way for piping and conduit installed at the required slope.
 - d. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions, and clear of the working and access space of other equipment.
- 4. Coordinate installation of the required supporting devices.
- 5. Coordinate the location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
 - a. Access doors and panels are specified in Section 08311, Access Doors and Frames.



6. Coordinate sleeve selection and application with the selection and application of firestopping specified in Section 07850, Through Penetration Firestopping Systems.

B. Sequencing:

1. Provide sleeves for electrical penetrations through concrete slabs and walls during the erection of the slabs and walls.
 - a. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Sleeves for raceways and cables.
 - 2) Sleeve seals.
 - 3) Grout.
 - b. Shop Drawings:
 - 1) Coordination Drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.



3. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Product Data:
 1. Submit manufacturer's Product Data and installation instructions for each proposed material and accessory to the Program/Project Manager for approval.

2.02 MATERIALS:

- A. Sleeves for Raceways and Cables:
 1. Steel Pipe Sleeves:
 - a. Provide galvanized steel pipe sleeves complying with the requirements specified for Type E, Grade B, Schedule 40 pipe in ASTM A 53/A 53M, and having plain ends.
 2. Cast-Iron Pipe Sleeves:
 - a. Unless otherwise indicated, provide cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
 3. Sleeves for Rectangular Openings:
 - a. Provide galvanized sheet steel sleeves for rectangular openings.
 - b. Minimum Metal Thickness:
 - 1) For a sleeve cross-section rectangle perimeter less than 50 inches with no side more than 16 inches, provide a metal thickness not less than 0.052 inch.
- B. Sleeve Seals:
 1. Provide a modular sealing device, designed for field assembly, to fill the annular space between the sleeve and raceway or cable
 2. Sealing Elements:
 - a. Provide EPDM or NBR interlocking links shaped to fit the surface of the cable or conduit.
 - 1) Provide the type and number required for the material and size of the raceway or cable.
 3. Pressure Plates:



- a. Provide 2 stainless steel pressure plates for each sealing element.
4. Connecting Bolts and Nuts:
 - a. Provide carbon steel connecting bolts and nuts with corrosion-resistant coatings of length required to secure the pressure plates to the sealing elements.
 - b. Provide one connecting bolt and nut for each sealing element.
5. Manufacturers:
 - a. Advance Products & Systems, Inc., www.apsonline.com.
 - b. Calpico, Inc., www.calpicoinc.com.
 - c. Metraflex Co., www.metralflex.com.
 - d. GPT Industries, <https://www.gptindustries.com>.
 - e. Manufacturer providing an equivalent product approved by the Program/Project Manager.

C. Grout:

1. Nonmetallic, Shrinkage-Resistant Grout:
 - a. Provide factory-packaged, nonmetallic aggregate, shrinkage-resistant grout complying with the requirements specified in ASTM C 1107/C 1107M.
 - b. Provide grout, that when mixed with water, will produce a noncorrosive, non-staining material with a consistency suitable for the application, and a 30-minute working time.

2.03 SOURCE QUALITY CONTROL

A. Coordination of Other Tests and Inspections:

1. Notify the code-required Approved Agency responsible for performing special inspections when the ground fault protection system; switchboards, panelboards, motor control centers and other equipment rated 100 Amperes or more, or over 600 Volts; single phase transformers rated 100 kVA or more and three phase transformers rated 300 kVA or more; conductors rated at 1000 Amperes or more and conductors rated over 600 Volts; and emergency and standby power systems including switchboards, panelboards, distribution boards, transfer equipment, power sources, conductors, fire pumps, exhaust fans, and ventilation fans for this Contract are being installed and/or tested.
2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify final equipment locations for roughing-in.

3.02 PREPARATION

- A. Demolition/Removal:
 - 1. Electrical Demolition:
 - a. Comply with the general demolition requirements and procedures specified in Section 01732, Cutting and Patching, and Section 01736, Selective Demolition.
 - b. Disconnect, demolish, and remove electrical systems, equipment, and components indicated to be removed.

3.03 INSTALLATION

- A. Comply with the requirements specified in NECA 1.
- B. Equipment:
 - 1. Install equipment so service, maintenance, and repair or replacement of components, both of the electrical equipment itself and of other nearby installations, can be readily performed.
 - 2. Connect equipment in a manner so disconnecting it in the future will result in minimum interference with other items in the vicinity.
- C. Mounting Heights:
 - 1. For suspended items, measure the mounting heights indicated in the Contract Documents to the bottom of the unit.
 - 2. For wall-mounting items, measure the mounting heights indicated in the Contract Documents to the center of the unit.
 - 3. Headroom Maintenance:
 - a. If mounting heights or other location criteria are not indicated in the Contract Documents, arrange and install components and equipment to provide the maximum possible headroom consistent with other requirements.
- D. Installing Sleeves for Electrical Penetrations:
 - 1. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.



2. Provide pipe sleeves for electrical penetrations unless the penetration arrangement requires a rectangular sleeved opening.
 - a. Cut the sleeves to length so the mounted sleeves are flush with both surfaces of the wall.
 - b. For sleeves installed in floors, extend the sleeve 2 inches above the finished floor level.
 - c. Unless indicated otherwise in the Contract Documents, size pipe sleeves to provide a 1/4-inch annular clear space between the sleeve and the raceway or cable.
 - d. For electrical penetrations through concrete slabs and walls, provide sleeves for the penetrations unless core-drilled holes or formed openings are provided.
3. For electrical penetrations through fire-rated floor and wall assemblies, provide sleeves for the penetrations, unless openings compatible with the firestop system used are fabricated during construction of the floor or wall.
4. For penetrations of concrete and masonry, seal the space outside of the sleeves with grout.
 - a. Promptly pack grout solidly between the sleeve and the wall so no voids remain.
 - b. Tool exposed surfaces smooth.
 - c. Protect the grout while it cures.
5. For interior electrical penetrations of non-fire-rated walls and floors, seal the annular space between the sleeve and the raceway or cable using joint sealant appropriate for the size, depth, and location of the joint in accordance with the requirements specified in Section 07920, Joint Sealants.
6. For raceway and cable penetrations of fire-rated walls, partitions, ceilings, and floors, maintain the original fire rating indicated in the Contract Documents.
 - a. Provide raceway and cable penetration sleeves, and seal the sleeves with firestop materials in accordance with the requirements of Section 07850, Through Penetration Firestopping Systems.
7. For electrical penetrations of roofs, provide flexible boot-type flashing "roof-penetration sleeves" applied in coordination with the roofing work to seal individual raceway and cable penetrations.
8. For aboveground electrical penetrations of exterior walls, provide steel pipe sleeves and mechanical sleeve seals to seal the penetration.
 - a. Select a sleeve sized to create a 1-inch annular clear space between the raceway or cable and the sleeve to allow installation of the mechanical sleeve seals.
9. For underground electrical penetrations of exterior walls, provide cast-iron pipe sleeves.



- a. Select a sleeve sized to create a 1-inch annular clear space between the raceway or cable and the sleeve to allow installation of the mechanical sleeve seals.
- E. Installing Sleeve Seals for Electrical Penetrations:
 1. Provide sleeve seals to seal exterior wall penetrations.
 2. Provide the type and number of sealing elements recommended by the sleeve seal manufacturer for the raceway or cable size and material.
 - a. Position the raceway or cable in the center of the sleeve.
 - b. Assemble the mechanical sleeve seals, and install them in the annular space between the raceway or cable and the sleeve.
 - c. Tighten the bolts against the pressure plates that cause the sealing elements to expand and make a watertight seal.
- F. Special Techniques:
 1. Firestopping:
 - a. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore the original fire-resistance rating of the assembly.
 - b. Provide firestopping materials complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems
- G. Interface with Other Work:
 1. Right of Way:
 - a. Give right-of-way to piping systems so they can be installed at a required slope.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/062017	N/A	All	First edition.



SECTION 16055

OVERCURRENT PROTECTIVE DEVICE COORDINATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for computer-based, fault-current and overcurrent protective device coordination studies.
 - 2. Requirements for protective devices set based on results of a protective device coordination study.
 - a. Coordination of series-rated devices is permitted where indicated on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. RMS: Root-mean-square.
- B. Definitions:
 - 1. X/R Ratio: The ratio of electrical reactance to electrical resistance in the electrical power supply.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book).
 - b. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
 - c. IEEE 399 - IEEE Recommended Practice for Power Systems Analysis (Brown Book).
 - d. IEEE 1015 - IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (Blue Book).
 - e. IEEE C37.20.1 - Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
 - f. IEEE C37.46 - American National Standard Specifications for Power Fuses and Fuse Disconnecting.



- g. IEEE C57.12.00 - IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers.
- h. ANSI/IEEE C57.12.10 - Transformers - 230 kV and Below, 833/958 through 8333/10 417 kVA, Single-Phase, and 750/862 through 60 000/80 000/100 000 kVA, Three-Phase without Load Tap Changing; and 3750/4687 through 60 000/80 000/100 000 kVA with Load Tap Changing – Safety Requirements.
- i. IEEE C57.12.22 – Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Volt Bushings, 2500 kVA and Smaller: High-Volt, 34 500 Grd Y/19 920 Volts and Below; Low Voltage, 480 Volts and Below.
- j. ANSI/IEEE C57.12.40 – IEEE Standard Requirements for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed).
- k. IEEE C57.96 - IEEE Guide for Loading Dry Type Distribution and Power Transformers.
- l. IEEE 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations.
- 3. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1 - Motors and Generators.
- 4. Insulated Cable Engineers Association (ICEA):
 - a. ICEA P-32-382 - Short-Circuit Characteristics of Insulated Cable.
 - b. ICEA P-45-482 - Short-Circuit Performance of Metallic Shielding and Sheaths.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Relevant Submittals for equipment provided under other Sections of this Contract, including the Product Data for its overcurrent protective devices, must be prepared prior to the performance of the studies required under this Section.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Computer software program to be used for the studies.
 - b. Certificates:
 - 1) Software certification for the coordination-study and fault-current-study computer software programs.
 - c. Special Procedure Submittals:
 - 1) Fault-Current Study Report.
 - 2) Equipment Fault-Current Evaluation Report.
 - 3) Coordination-Study Report.



- 4) Data sheets for setting the overcurrent protective devices.
- 5) Arc Flash Study and Labels
- d. Qualification Statements:
 - 1) Coordination-study specialist's qualifications.
 - 2) Professional Engineer's qualifications.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 - 1. Coordination-Study Specialist's Qualifications:
 - a. Employ an entity experienced in applying computer software to the development of fault-current and overcurrent protective device coordination studies, and who has performed successful studies on electrical distribution systems of similar magnitude and using similar devices to those provided under this Contract.
 - b. Submit the coordination-study specialist's qualifications to the Program/Project Manager for approval.
 - 2. Professional Engineer's Qualifications:
 - a. Employ a Professional Engineer, licensed in the State of Arizona, to be responsible for the supervising the preparation of the fault-current and overcurrent protective device coordination study.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Software Certification:
 - a. For the coordination-study and fault-current-study computer software programs, submit software certification certifying that the software complies with the requirements specified in IEEE 399 to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 COORDINATION STUDIES

- A. Design Criteria:
 - 1. Perform the elements of the Fault-Current Study and the Overcurrent Protective Device Coordination Study under the direct supervision and control of the Professional Engineer.
 - 2. Perform fault-current and overcurrent protective device coordination study elements under the direct supervision and control of the Professional Engineer.



3. Perform Arc-Flash Study and equipment labels under the direct supervision and control of the Professional Engineer.
4. Comply with the requirements specified in IEEE 399 for general study procedures.
5. Comply with the requirements specified in IEEE 242 for short-circuit currents and coordination time intervals.
6. Overcurrent Protective Devices:
 - a. Examine the overcurrent protective device Submittals furnished under this Contract to verify compliance with the electrical distribution system coordination requirements and other conditions affecting performance.
 - 1) The devices to be coordinated are indicated on the Contract Drawings.
 - 2) Proceed with the coordination study only after relevant equipment submittals have been assembled.
 - 3) Overcurrent protective devices that have not been submitted and approved prior to the coordination study may not be used in study.
7. Power System Data:
 - a. Gather and tabulate the following power system input data for the systems indicated on the Contract Drawings to support preparation of the coordination study:
 - 1) Product Data:
 - a) Obtain Product Data for the overcurrent protective devices specified in other Sections that are required for preparing the overcurrent protective device coordination studies.
 - b) Use equipment designation tags consistent with the electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2) Impedance of the utility service entrance.
 - 3) Electrical Distribution System Diagram:
 - a) Obtain an electrical distribution system diagram in both hard-copy and electronic formats showing the following:
 - (1) Circuit-breaker and fuse-current ratings and types.
 - (2) Relays and associated power and current transformer ratings and ratios.
 - (3) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - (4) Cables:
 - (a) Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - (5) Busway ampacity and impedance.
 - (6) Motor horsepower, and the code letter designation in accordance with the requirements specified in NEMA MG 1.



- 4) Data sheets to supplement the electrical distribution system diagram, cross-referenced with tag numbers on the diagram, and showing the following:
 - a) Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b) Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c) Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d) Ratings, types, and settings of the utility company's overcurrent protective devices.
 - e) Special overcurrent protective device settings or types stipulated by the utility company.
 - f) Time-current-characteristic curves of devices indicated to be coordinated.
 - g) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - i) Panelboards, switchboards, motor-control center ampacity, and interrupting rating in Amperes rms symmetrical.
8. Computer Software Program:
 - a. To perform the studies, furnish and use computer programs that are nationally distributed and widely used to perform studies of the type required by this Section.
 - 1) Manual calculations are not acceptable.
 - 2) Software algorithms in the programs must comply with the requirements of the standards and guides specified within this Section.
 - b. Furnish computer software programs complying with the requirements specified in IEEE 399, and that have the following features:
 - 1) Capable of plotting and diagramming time-current-characteristic curves as part of their output.
 - 2) Capable of reporting device settings and ratings of all overcurrent protective devices.
 - 3) Capable of demonstrating selective coordination by computer-generated, time-current coordination plots.
 - 4) The fault-current-study computer software program must include the following analytical features as listed in IEEE 399:
 - a) Mandatory.
 - b) Very desirable.
 - c) Desirable.



- 5) The computer software programs optionally may include provisions for assessing the following features:
 - a) Arcing faults.
 - b) Simultaneous faults.
 - c) Explicit negative sequence.
 - d) Mutual coupling in zero sequence.
 - c. Fault-Current Study and Coordination Study Computer Software Developers include the following:
 - 1) CYME International T & D, Inc., www.cyme.com.
 - 2) EDSA Corporation, Inc., www.edsa.com.
 - 3) ESA, Inc./EasyPower, www.easypower.com.
 - 4) Operation Technology, Inc., <http://etap.com>.
 - 5) SKM Systems Analysis, Inc., www.skm.com.
 - 6) Approved equal.
 - d. Submit Product Data for the computer software program(s) to be used for the studies to the Program/Project Manager for approval.
 9. After the approval process for system protective devices has been completed, submit the following items to the Program/Project Manager for approval:
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and Equipment Evaluation Reports.
 - c. Coordination-Study Report.

B. Fault-Current Study:

 1. Perform the Fault-Current Study using an approved computer software program.
 2. Calculate the maximum available short-circuit current in amperes rms symmetrical at the circuit-breaker positions of the electrical power distribution system.
 - a. Perform the calculation for a current immediately after initiation and for a three-phase bolted short circuit at each of the following in the system:
 - 1) Switchgear and switchboard bus.
 - 2) Motor-control center.
 - 3) Distribution panelboard.
 - 4) Branch circuit panelboard.
 3. Study the electrical distribution system from normal and alternate power sources throughout the electrical distribution system of the Project.
 - a. Include studies of system-switching configurations, and alternate operations, that could result in maximum fault conditions.
 4. Calculate momentary and interrupting duties on the basis of maximum available fault current.
 5. Perform calculations to verify the interrupting ratings of the overcurrent protective devices in accordance with the requirements specified in IEEE 141 and IEEE 242 for the following:
 - a. Transformers:



- 1) Transformers, 230 kV and below, complying with the requirements specified in ANSI/IEEE C57.12.10.
- 2) Pad-mounted, compartmental-type, self-cooled, three-phase distribution transformers complying with the requirements specified in IEEE C57.12.22.
- 3) Secondary network transformers, subway and vault types (liquid immersed), complying with the requirements specified in ANSI/IEEE C57.12.40.
- 4) Liquid-immersed distribution power and regulating transformers complying with the requirements specified in IEEE C57.12.00.
- 5) Dry type distribution and power transformers complying with the requirements specified in IEEE C57.96.
- b. Low-Voltage Circuit Breakers:
 - 1) Low-voltage circuit breakers complying with the requirements specified in IEEE 1015 and IEEE C37.20.1.
- c. Low-Voltage Fuses:
 - 1) Low-voltage fuses complying with the requirements specified in IEEE C37.46.
6. Fault-Current and Arc-Flash Study Report:
 - a. Prepare a Fault-Current Study Report showing the calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on the electrical distribution system diagram.
 - b. After the approval process for system protective devices has been completed, submit the Fault-Current Study Report to the Program/Project Manager for approval.
7. Equipment Fault-Current Evaluation Report:
 - a. Prepare a Fault-Current Equipment Evaluation Report.
 - b. For 600 Volt overcurrent protective devices, ensure that the interrupting ratings are equal to or higher than the calculated 1/2-cycle symmetrical fault current.
 - c. For devices and equipment rated for asymmetrical fault current, apply the multiplication factors listed in the standards to the 1/2-cycle symmetrical fault current.
 - d. Verify the adequacy of the phase conductors at the maximum three-phase bolted fault currents.
 - e. Verify the adequacy of the equipment grounding conductors and grounding electrode conductors at the maximum ground-fault currents.
 - f. Ensure that the short-circuit withstand ratings are equal to or higher than the calculated 1/2-cycle symmetrical fault current.
 - g. After the approval process for system protective devices has been completed, submit the Fault-Current Equipment Evaluation Report to the Program/Project Manager for approval.
- C. Overcurrent Protective Device Coordination Study:
 1. Perform an Overcurrent Protective Device Coordination Study using an approved computer software program, and in accordance with the requirements specified in IEEE 399.



2. Comply with the recommendations for fault currents and time intervals in IEEE 141.
3. Transformer Primary Overcurrent Protective Devices:
 - a. The transformer primary overcurrent protective devices may not operate in response to the following:
 - 1) Inrush current when first energized.
 - 2) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - 3) Permissible transformer overloads in accordance with the requirements specified in IEEE C57.96 if required by unusual loading or emergency conditions.
 - b. For fault currents, transformer primary overcurrent protective device settings must protect transformers according to IEEE C57.12.00.
4. Conductor Protection:
 - a. Protect cables against damage from fault currents in accordance with the requirements specified in ICEA P-32-382 and ICEA P-45-482, and the conductor melting curves in IEEE 242.
 - b. Demonstrate that the equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse.
 - c. To determine the temperatures that damage the insulation, use curves from the cable manufacturers or from listed standards indicating the conductor size and short-circuit current.
5. Coordination-Study Report:
 - a. Prepare a written Coordination-Study Report using the results of the Fault-Current Study, and after the approval process for system protective devices has been completed submit the Coordination-Study Report to the Program/Project Manager for approval.
 - 1) Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2) Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3) Calculate the maximum and minimum ground-fault currents.
 - b. Include the coordination-study input data, including completed computer program input data sheets, in the Coordination-Study Report.
 - c. Indicate the following results of the coordination study in the Coordination-Study Report:
 - 1) Settings selected for overcurrent protective devices in tabular format, including the following information:
 - a) Device tag.
 - b) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c) Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d) Fuse-current rating and type.



- e) Ground-fault relay-pickup and time-delay settings.
- 2) Coordination Curves:
 - a) Prepare coordination curves to determine the settings of the overcurrent protective devices required to achieve selective coordination.
 - b) Graphically illustrate that adequate time separation exists between the devices installed in series, including the power utility company's upstream devices.
 - c) Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation.
 - d) Show the following information on the coordination curves:
 - (1) Device tag.
 - (2) Voltage and current ratio for curves.
 - (3) Three-phase and single-phase damage points for each transformer.
 - (4) No damage, melting, and clearing curves for fuses.
 - (5) Cable damage curves.
 - (6) Transformer inrush points.
 - (7) Maximum fault-current cutoff point.
- D. Data Sheets for Setting the Overcurrent Protective Devices:
 - 1. Prepare completed data sheets for setting the overcurrent protective devices, and submit them to the Program/Project Manager for information.
- E. ARC FLASH HAZARD ANALYSIS
 - 1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2015, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.
 - 2. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
 - 3. Circuits 120V or less where available bolted short circuit current is less than 10 kA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E Table 130.7(C)(9)(a), including footnote 3.
 - 4. Circuits 120V or less fed by transformers 30 kVA or less may be omitted from the computer model and will be assumed to have a hazard risk category 0 per IEEE 1584.



5. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
6. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
7. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.
8. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
9. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
10. Fault contribution from induction motors should not be considered beyond 5 cycles.
11. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.



12. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
13. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
14. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
15. Provide the following:
 - a. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
 - b. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
 - c. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.
- 16.

PART 3 EXECUTION

3.01 ARC FLASH SIGNAGE

1. Provide a machine printed 4-inch x 4-inch (nominal) thermal transfer type label of high adhesion polyester for each location identified in the arc flash study. Labels for equipment located outdoors shall include UV resistant laminate.
2. Labels shall include the following machine printed information (hand lettering is not acceptable): equipment name, flash hazard boundary, incident energy, boundaries for shock hazard, limited approach, and restricted approach, PPE (personal protective equipment) category and date.



3. One label shall be required at each applicable section of switchgear, switchboard, or motor control center; and each 480-volt disconnect switch, 480-volt control panel or panelboard. For service entrance equipment provide label for line side and load side.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16061

ELECTRICAL GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for connecting, energizing, testing, cleaning, and protecting grounding and bonding systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 02300 - Earthwork.
 - 4. Section 02316 - Trenching and Backfilling.
 - 5. Section 16050 - Basic Electrical Materials and Methods.
 - 6. Section 16080 - Electrical Testing.
 - 7. Section 16130 – Raceway and Boxes.

1.02 REFERENCE STANDARDS:

- A. American Public Works Association (APWA):
 - 1. APWA Public Works Management Practices Manual.
- B. ASTM International (ASTM):
 - 1. ASTM B 1 - Standard Specification for Hard-Drawn Copper Wire.
 - 2. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 3. ASTM C 65 - Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation.
 - 4. ASTM D 5 - Standard Test Method for Penetration of Bituminous Materials.
 - 5. ASTM D 149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
 - 6. ASTM D 257 - Standard Test Methods for D-C Resistance or Conductance of Insulating Materials.
 - 7. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code (NEC).
- D. National Electrical Manufacturing Association (NEMA):
 - 1. NEMA TC-2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.



2. NEMA TC-3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
3. NEMA TC-14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
4. NEMA WC-7 - Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

E. Underwriter's Laboratories, Inc. (UL):

1. UL 467 - Standard for Grounding and Bonding Equipment.
2. UL 486A-486B - Wire Connectors.
3. UL 486C - Standard for Splicing Wire Connections.
4. UL 486D - Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
5. UL 486E - Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

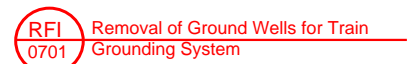
1.03 COORDINATION:

- A. Coordinate the Work of this Section with the locations for grounding connections of electrical conduit and boxes, equipment, lighting fixtures, motors, transformers, and isolated ground receptacles requiring grounding under this Contract.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Manufacturers catalog cuts.
 - b. Shop Drawings:
 - 1) Ground well grid installation in unpaved areas.
 - 2) Ground well grid installation in paved areas.
 - 3) Ground bus installation.
 - c. Samples:
 - 1) Ground wire.
 - d. Certificates:
 - 1) Testing agency product certification.
 - e. Qualification Statements:
 - 1) System installers' qualifications.
 - 2) Installation supervisors' resumes.



B. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:



- a. Operation and Maintenance Data:
 - 1) Operation and Maintenance Manuals.
- b. Record Documentation:
 - 1) Record drawings showing the actual installed elevations and locations of grounding cables and rods for both concealed and exposed work.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. All grounding and bonding Work must comply with the requirements of NFPA 70, the National Electrical Code.
 - 2. Within 60 days of the Contract award, submit the Submittals required by Section 16050, Basic Electrical Materials and Methods, to the Program/Project Manager for approval:
 - a. Include Product Data and Catalog Cuts for all products provided, and describe the usage of each product.
- B. Qualifications:
 - 1. Installer Qualifications:
 - a. Employ installers who specialize in the work of this Section, and who can demonstrate a minimum of 3 years documented experience.
 - b. Submit the system installers' qualifications.
 - 2. Supervisor's Qualifications:
 - a. Employ supervisor to supervise the installation work who are skilled licensed electricians.
 - b. Submit the installation supervisors' resumes.
- C. Certifications:
 - 1. Testing Agency Product Certification:
 - a. Verify product quality by certifying products as meeting the requirements of Underwriters Laboratories, Inc. (UL).
 - a) Provide products listed and labeled by UL.
 - b. Testing agency product certification must include agency listing and labeling, either by a printed mark on the data or by a separate listing card.
 - 1) If an item does not have this quality assurance verification, provide a written statement from the product manufacturer indicating why not; such manufacturer's statements are subject to the approval of the Owner and the Program/Project Manager.
- D. Site Samples:
 - 1. Submit 8 inch long Samples of the types of ground wire to be used to the Program/Project Manager for approval.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Transport materials, both onsite and from the Contractor's storage to the Site, in accordance with the recommendations of the respective manufacturers.
- B. Storage and Handling Requirements:
 - 1. Store materials, both on and off the Site, in accordance with manufacturer's written instructions.
 - 2. Store products indoors on blocking or pallets.

PART 2 PRODUCTS

2.01 COMPONENTS

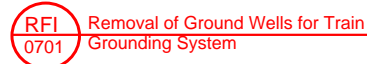
- A. Conduit and Conduit Fittings:
 - 1. For conduit and conduit fittings that enclose single ground wires without accompanying circuit conductors provide one of the following:
 - a. Schedule 80, non-metallic conduit and fittings conforming to the requirements of Section 16131, Conduit and Tubing, and the conduit additionally conforming to the requirements of NEMA TC-2, and the fittings additionally conforming to the requirements of NEMA TC-3.
 - b. Fiberglass reinforced plastic (FRP) conduit and fittings conforming to the requirements of NEMA TC-14 and Section 16131, Conduit and Tubing.
 - 2. For other conduit and conduit fittings, provide conduit of the types specified or indicated and that conform to the requirements of Section 16131, Conduit and Tubing.
- B. Wire:
 - 1. Bare Ground Wire:
 - a. For Number 6 or larger bare ground wire sizes, provide soft drawn copper, Class A or Class B, stranded wire meeting the requirements of ASTM B 8.
 - b. For Number 8 or smaller bare ground wire sizes, provide soft drawn solid copper wire meeting the requirements of ASTM B 1.
 - 2. Insulated Ground Wire:
 - a. For Number 10 or larger insulated ground wire sizes, provide type XHHW insulated Class B copper stranded wire rated for 600 volts that conforms to the requirements of NEMA WC-7, and is green in color.
 - b. For Number 12 or smaller insulated ground wire sizes, provide type XHHW insulated solid copper wire rated for 600 volts that conforms to NEMA WC-7, and is green in color.
- C. Clamps and Non-Welded Connectors:



1. Provide bronze or brass clamps and connectors that are UL listed for use below grade.
 - a. All bolts and other material must be bronze or brass, plated steel screws are unacceptable.
 - b. Fabricate multi-bolt, solderless compression clamps from high strength electrical bronze, and provide silicon bronze clamping bolts and hardware.
2. Provide bolts, nuts, lock-washers, and similar hardware designed not to damage ground wire.
3. Manufacturers:
 - a. Acceptable manufacturers of clamps and connectors include the following:
 - 1) IlSCO, www.ilsco.com.
 - 2) Framatone Connectors Inc. (FCI), Burndy, <http://portal.fciconnec.com>.
 - 3) Approved equal.

D. Ground Rods:

1. Provide UL listed, sectional ground rods fabricated using a molten weld casting process to copper clad a medium carbon steel core
2. Diameter: 3/4 inch.
3. Length: 10 feet.
 - a. To obtain longer length rods, join rod sections using copper clad rod couplers.



E. Concrete Protective Boxes (Ground Wells):

1. Provide precast concrete boxes with flush cast iron covers rated for heavy traffic areas and having slots for conduit entrances.
 - a. Minimum size: 10-inch diameter by twelve inches high.
 - b. Cover legend: Provide the cast-in legend "GROUND" in the cast iron covers provided.
2. Within 60 days of the Contract award, submit the following to the Program/Project Manager for approval:
 - a. Shop Drawings for the ground well grid installation in unpaved areas.
 - b. Shop Drawings for the ground well grid installation in paved areas.

2.02 DESCRIPTION:

A. Regulatory Requirements:

1. Ground the conduit systems, metal enclosures, equipment frames, motors, and receptacles in accordance with Article 250 of NFPA 70, Grounding.
 - a. Ground all metallic conduits, wiring channels, and armored cables continuously from outlet to outlet, and from outlets to cabinets, junction boxes, or pull boxes.



- 1) Bond each run of raceways to form a continuous path for ground faults from end to end.
 - 2) When liquid tight flexible metal conduit sizes larger than 1-inch or flexible metal conduit are installed, provide external bond wires.
 - b. Grounding Bushings:
 - 1) Provide all 1-inch or larger metallic conduits with grounding bushings unless they enter metallic enclosures via integral threaded hubs.
 - 2) Provide grounding bushings for conduits entering the bottom of freestanding equipment.
 - 3) Bond wire from every grounding bushing to the equipment ground stud or ground bus in the enclosure.
 - 4) Bond the grounding bushings to ground studs or ground buses in the enclosures.
 - c. Provide insulated, Type XHHW internal equipment ground wire in all conduits.
 - 1) Bond the internal wire to all pullboxes, junction boxes, equipment enclosures, and other enclosures as required by NFPA 70.
 2. Equipment Grounds:
 - a. Design all feeders and branch circuits to include an equipment grounding conductor consisting of a copper wire within a raceway or cable and sized as specified herein.
 - 1) Where conductors are run in parallel in multiple raceways, run the equipment grounding conductor in parallel to the related conductors.
 - 2) Size each of the parallel equipment grounding conductors on the basis of the ampere rating of the circuit overcurrent protecting device.
 - b. Ground enclosing cases, mounting frames, rack mounted components, rack struts, switches, breakers, control panels, motors, and other electrical or electrically operated equipment by providing an equipment grounding conductor with phase conductors from an established equipment ground source.
- B. Design Criteria
1. Design the electrical system installation to conform to Article 300 of NFPA 70, Wiring Methods, and to other applicable articles of NFPA 70 governing methods of wiring.
 2. Ground Wire Sizes:
 - a. The minimum size for bonding jumpers, equipment ground conductors, grounding electrode conductors, and ground grid conductors is as follows:
 - 1) Under 600 volts:
 - a) Provide Number 10 AWG, minimum.
 - 2) Over 600 volts:



- a) For transformers, provide Number 2 AWG ground wire, minimum.
 - b) For motors, provide Number 4 AWG ground wire, minimum.
- b. When the ground wire size is not specified or indicated on the Contract Drawings, provide wire sized in accordance with the requirements of NFPA 70.
- 3. Ground Buses:
 - a. Size ground buses to carry 100 percent of the rating or setting of the largest over current device in the circuit(s) ahead of the equipment, conduit, or other item, and as indicated on the Contract Drawings.
 - b. Within 60 days of the Contract award, submit Shop Drawings for ground bus installations to the Program/Project Manager for approval.

2.03 ACCESSORIES

A. Exothermic Welding Kits:

- 1. Provide molds, thermite packages, and other material for exothermic welds that are rated to carry 100 percent of the cable ratings, and which are letter-coded exothermic welded type.
- 2. Provide all items such as tees, crosses, splices, and cable connections necessary for connecting ground and bonding cables to the following items:
 - a. Ground rods.
 - b. Reinforcing steel bars.
 - c. Ground-bus.
 - d. Structural steel.
 - e. Water pipe.
 - f. Bonding to the main-ground-grid.
- 3. Manufacturers:
 - a. Provide all exothermic welding molds, thermite packages, and other material used throughout the Work from a single manufacturer.
 - b. Acceptable manufacturers of exothermic welded connector are as follows:
 - 1) Electric Railway Improvement Company (ERICO), Cadweld®, www.erico.com.
 - 2) Continental Industries, Inc., Thermoweld®, www.conind.com.
 - 3) Approved equal.

B. Coating Compound:

- 1. Provide permanently pliable, moldable, un-backed, black rubber based coating materials for covering or coating grounding clamps and connectors.
- 2. Coating Physical Properties:
 - a. Solids/Density: 100 percent; 12 pounds per gallon.
 - b. Penetration: Within 90 to 130 when tested in accordance with ASTM D 5.



- c. Water Absorption: 0.10 percent, maximum, when tested in accordance with ASTM D 570.
 - d. Dielectric Strength: 500 volts/mil when tested in accordance with ASTM D 149.
 - e. Volume Resistivity: 2,000 megohm-inches, or 5,000 megohms-cm, when tested in accordance with ASTM D 257.
 - f. Service Temperature: Minus 40 degrees to 160 degrees Fahrenheit; and having no melting point; flammability, or slow burning when tested in accordance with ASTM C 653.
 - g. Chemical Resistance:
 - 1) Resistant to alcohol, water, aqueous hydrochloride, and sodium hydroxide.
 - 2) Dissolved by carbon tetrachloride, naphtha gasoline, mineral spirits, and benzene.
 - h. Cohesive/Adhesive: Adheres to metals, concrete, and itself.
- C. Underground Warning Tape:
- 1. Provide underground warning tape fabricated from polyethylene material with one-inch high, minimum, overcoated printed warning message lettering.
 - a. Tape thickness: 4 mils, minimum.
 - b. Graphic Message: "CAUTION - BURIED ELECTRIC LINE".
 - c. Tape Background Color: Red per the APWA Uniform Color Code as described in the APWA Public Works Management Practices Manual.
 - 2. Manufacturers:
 - a. Acceptable manufacturers of underground warning tape include the following:
 - 1) Signmark Division, Brady USA, Inc., Item No.11296, www.bradycorp.com.
 - 2) Seton, www.seton.com.
 - 3) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
- 1. The Contract Drawings are generally indicative of the Work, but due to their small scale, it is not possible to indicate some offsets and fittings required nor the minor structural obstructions that may be encountered.
 - a. Perform field measurements to discover offsets and fitting requirements not shown.
 - b. Locate all on-site utilities and other obstructions in the area of construction, and verify that interferences will not occur.
- B. Evaluation and Assessment:

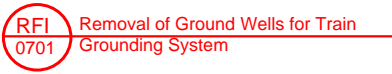


1. Layout electrical work to suit actual field conditions and in accordance with accepted standard practice.

3.02 SURFACE PREPARATION:

- A. Perform required earthwork including excavation, backfill, and compaction, as specified in Section 02300, Earthwork, and Section 02316, Trenching and Backfilling.

3.03 INSTALLATION

- A. Install each ground system and connection so it is mechanically secure and electrically continuous.
- B. Ground Grids:
 1. Installing Ground Rods:
 - a. Drive ground rods head to 6 inches below grade by using a ground rod cap to protect the head of the rod.
 - 1) If the top of the rod is damaged during driving operations, cut it off.
 2. Installing Ground Wells: 
 - a. Install a concrete protective box for the ground well flush with the grade and 4 inches above the top of the ground rod designated on the Contract Drawings.
 3. Installing Ground Wires:
 - a. Excavate the trenches for the ground grid cables, and lay the ground cable in the trenches from ground rod to ground rod without splice, and from one side of the grid to the other as shown on the Contract Drawings.
 - 1) Lay the ground grid cables cable allowing 10 percent slack.
 - 2) Form 12-inch minimum radius bends at changes in direction.
 - 3) At intersections, place cables so they diverge 60 degrees or more from other cables at the intersection.
 - 4) Connect service entrance grounds directly to the ground grids without splices in the cable.
 - b. Route connecting cables from the ground grid in the trenches to buildings and structures.
 - 1) Route exposed cables parallel to the building lines, except for bends; form all bends with a 12-inch minimum radius.
 - 2) Wherever the cable breaks grade, provide schedule 80 conduit from 2-feet below finished grade to 3-feet above finished grade for protection; and provide conduit at other points where the cable may be subject to damage.
 - c. Clamp the conduit to the building structure's wall at the ends and at intervals not to exceed 5 feet.



- 1) Whenever cable exits from the conduit, clamp the cable to the wall at intervals not to exceed 5 feet and at each entrance to equipment.
 - 2) Allow a 1/4 inch space between ground cables, conduit, and the surface it is mounted on.
 - d. Remove any damaged or kinked cable.
 - e. Weld ground wires to the ground rods and equipment connections.
 - 1) Follow the procedures of the exothermic welding kits manufacturer.
 - 2) Prior to welding ground wires to the ground rods and equipment connections perform the following:
 - a) Clean the proposed welding area of combustible and flammable materials; and block access to personnel to protect them from harm; and provide a shield to prevent damage to other materials.
 - b) Clean insulation from ground wire for a distance of 12 inches, and clean the exposed wire to a bright finish.
 - c) Clean paint, grease, and other similar insulating materials from contact points.
 - d) Inspect the molds for damage; and discard any faulty mold or any molds used over 40 times.
 - 3) Exothermically weld the ground wires to the ground rods as shown on the Contract Drawings, including to ground rods at grid crossings, to ground rods at grid intersections on the sides of the ground grid, and at all equipment connections.
 - 4) After completing the welding, replace the insulation removed from insulated wires, and coat connections and the area around connections with coating compound.
 - a) Coating Thickness: 1/8-inch, minimum.
 - b) Make sure the coating is free from pin-holes and holidays.
4. Equipment Ground Buses:
 - a. Whenever several pieces of equipment, other than service grounds, require external bond wires in an area, provide an equipment ground bus.
 - b. Wherever 5 or more conduits enter a box or enclosure, provide an equipment ground bus.
 - 1) Connect all equipment ground wires and conduit bond wires within the box or enclosure to a single ground stud or single common ground bus.
5. Make all connections to electrical equipment and ground buses with compression, two-hole lugs and studs.
 - a. Clean paint, grease, and other similar insulating materials from the contact points for the ground lugs and studs.
 - b. Clean all wires to a bright finish prior to construction the connections.



6. After inspection by Program/Project Manager and Owner's representative, backfill the direct buried cables and around ground rod protectors.
 - a. Begin backfilling with clean washed sand to 6 inches above the ground rods or to the depth shown on the Contract Drawings, whichever is greater.
 - b. Backfill using select fill in accordance with the requirements of Section 02300, Earthwork.
 - c. Slope the finish grade away from ground rods at a slope of 1 inch in 18 inches for a distance of 27 inches from the rods in all directions.
7. Install marker tape above buried cables as indicated on the Contract Drawings.

C. Interface with Other Work:

1. Equipment Grounds:

- a. Install equipment grounds in spaces accessible to authorized personnel only.
- b. Equipment Grounding Connectors:
 - 1) Only use approved grounding connectors.
 - a) Terminate grounds with closed lugs with star washers on both sides and a 1/4-20 bolt and nut, minimum; spade lugs are not allowed.
 - b) For portable electrical equipment, provide electric cords having an equipment grounding conductor and a NEMA and UL approved cord cap.
 - 2) Do not install grounding lugs on flanges, mounting screws, or standoffs in switches, distribution boxes, or panels.
 - 3) Cover or coat grounding clamps and connectors with coating compound.
- c. Equipment Grounding Conductors:
 - 1) Unless using multi-conductor cable, run equipment grounding conductors inside the same conduit or wiring channel enclosing the power conductors.
 - 2) In multi-conductor cable, locate grounding conductor inside the sheath or cable.
 - 3) Do not use a system neutral or a current carrying conductor as the equipment grounding conductor.
 - a) Do not ground the electrical and electronic equipment neutral to chassis, racks, equipment ground conductor, or any non-current carrying conductor on the equipment.
- d. Grounding Lighting Fixtures:
 - 1) Provide the housing of each lighting fixture with a separate, factory-installed grounding device and ground conductor.
 - 2) Use the factory-installed grounding device for connecting a separate grounding conductor meeting applicable grounding requirements of NFPA 70 (NEC) to the fixture.



- a) Provide a green covered grounding conductor of the same wire gauge as the two power feed wires.
 - b) Provide a continuous ground for the fixture construction.
- e. Grounding Motors:
 - 1) Install equipment grounding wire within conduit supplying power to motor.
 - 2) Install bonding connectors across the liquid tight flexible conduit supplying motors.
- f. Grounding and Bonding Pumps:
 - 1) Provide a bond from each pump to its motor using a conductor equal in size to the motor circuit equipment grounding conductors.
- g. Grounding Transformers:
 - 1) If a transformer is a separately derived system as defined in NFPA 70, provide a ground wire in both the primary and secondary conduits; and bond both metallic wires and conduits to the nearest effectively grounded metallic water pipe or nearest effectively grounded structural steel column.
 - 2) Provide an additional bond between cold and hot water pipes located near a transformer bond connection.
- h. Grounding Isolated Ground Receptacles:
 - 1) Ground the receptacle grounding terminal via an insulated equipment grounding conductor routed with the circuit conductors within the raceway.
 - a) This grounding conductor may pass through one or more panelboards without being connected to the panelboard grounding terminal in order to terminate directly at an equipment grounding conductor terminal of the applicable separately derived system or service within the same building or structure.
 - 2) Use of isolated equipment grounding conductors does not remove the requirement for grounding the raceway system and outlet box.
- 2. Grounding Electrical Conduit and Boxes:
 - a. Clean paint, grease, and such other insulating materials from the contact points of grounds.
 - b. Secure grounds to boxes in such a manner that each system is electrically continuous from the point of service to each outlet.
 - c. Terminate conduits using double locknuts and bushings.
 - 1) Unless a conduit run enters a metallic enclosure via integral threaded hubs, provide the conduit run with two locknuts.

3.04 REPAIR

- A. Replace any finished exothermic welded splice connections that inspections find to be defective.
 - 1. Refer to Subparagraph 3.05.A.2.b for types of defective exothermic welded splice connections.



3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Testing:

- a. Prior to energizing any system, test the resistance to ground for the system in accordance with Section 16080, Electrical Testing.
 - 1) Perform a continuity test from all utilization and distribution equipment to the ground grid on a run-by-run basis.
 - 2) All tests shall conform to IEEE 142 and shall be acceptable less than 5 ohms.

2. Inspection:

- a. Prior to completion of the Work of this Section, inspect the items provided for conformity to the Contract Drawings and Specifications.
 - 1) Leave in-place "made grounds" open until they have been inspected and approved by the Program/Project Manager.
 - 2) Clean the surfaces involved in "made grounds" before connecting the grounds, and finish the installation with touch up painting or another protective coating to prevent corrosion.
- b. Inspect finished exothermic welded connections for the following defects:
 - 1) Conductors appear within the splice area.
 - 2) Top of splice risers are below conductors.
 - 3) Surfaces exhibiting more than 20 percent slag material.
 - 4) Surfaces with over slag material that has flowed into conductors.
 - 5) Mold blowouts.
 - 6) Excessive porosity.
 - a) Small pores less than 1/32 inch are permitted.
- c. Prepare and submit record drawings showing the actual installed elevations and locations of grounding cables and rods for both concealed and exposed work provided under this Contract.

3.06 PROTECTION

- A. Protect finished insulated wires from being painted.
- B. Protect all ground grid wells from damage during paving and landscaping.
- C. Protect all ground grid installations and ground wires from damage during the work of other Sections.

3.07 MAINTENANCE

- A. In accordance with Section 01780, Closeout Submittals, submit Operation and Maintenance Manuals that include Product Data for the products provided under this Section and the record drawings.

END OF SECTION



REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16070

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for hangers and supports for electrical equipment and systems, including the following:
 - a. Hangers.
 - b. Supports.
 - c. Concrete bases.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 03100 - Concrete Forms and Accessories.
 - 3. Section 03200 - Concrete Reinforcement.
 - 4. Section 03300 - Cast-In-Place Concrete.
 - 5. Section 05500 - Metal Fabrications.
 - 6. Section 09912 - Painting

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EMT: Electrical metallic tubing.
 - 2. IMC: Intermediate metal conduit.
 - 3. RMC: Rigid metal conduit.
- B. Reference Standards:
 - 1. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M – Structural Welding Code-Steel.
 - 2. ASTM International (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - c. ASTM A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 4. Metal Framing Manufacturing Association (MFMA):
 - a. MFMA-4 - Metal Framing Standards Publication.
 - 5. Manufacturers Standardization Society (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports – Materials, Design, and Manufacture.



- b. ANSI/MSS SP-69 - ANSI/MSS Edition Pipe Hangers and Supports – Selection and Application.
- 6. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practices for Good Workmanship in Electrical Construction
 - b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
- 7. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code.
- 8. Society for Protective Coatings (SSPC):
 - a. SSPC-PA 1 – Shop, Field and Maintenance Painting.
 - b. SSPC-PS Guide 1.00 - Guide for Selecting Oil Base Painting Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the size and location of concrete bases.
 - 2. Coordinate the installation of roof curbs, equipment supports, and roof penetrations-with the roofing installer.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Construction Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Steel slotted support systems.
 - 2) Nonmetallic slotted support systems.
 - 3) Trapeze hanger components.
 - 4) Steel slotted channel system components.
 - 5) Nonmetallic slotted channel system components.
 - 6) Equipment support components.
 - b. Shop Drawings:
 - 1) Trapeze hangers.
 - 2) Steel slotted channel systems.
 - 3) Nonmetallic slotted channel systems.
 - 4) Equipment supports.
 - c. Qualification Statements:
 - 1) Welding procedure qualification test records.
 - 2) Welding Certificates.
 - 3) Professional Engineer's qualifications.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:



1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 1. Welding Qualifications:
 - a. Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders and welding procedures to the Program/Project Manager for approval.
 - 1) For all procedures, other than those set forth in AWS D1.1/D1.1M, submit a copy of the welding procedure qualification test records.
 - b. Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M, for the procedures.
 - 1) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been AWS certified within the previous 12 months to the Program/Project Manager for approval.
 - a) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
 2. Professional Engineer's Qualifications:
 - a. Employ a licensed Professional Engineer, registered in the State of Arizona, having experience performing electrical hanger and support calculations.
 - b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Substitution Limitations:
 1. Subject to compliance with the requirements specified, manufacturers offering products that may be incorporated into the Work include the manufacturers listed.
- B. Product Options:
 1. Subject to compliance with requirements, provide products by one of the manufacturers listed.



2.02 DESIGN CRITERIA

- A. Structural Requirements:
 - 1. Provide electrical hangers and supports to be structurally adequate in tension, shear, and pullout force to resist the maximum loads calculated or imposed for this Contract, with a minimum structural safety factor of 5 times the applied force.
- B. Design supports for multiple raceways, including employing a qualified Professional Engineer to perform a comprehensive engineering analysis, using the performance requirements and design criteria specified.
- C. Design supports for multiple raceways to be capable of supporting the combined weight of the supported systems and their contents.
- D. Design equipment supports capable of supporting the combined operating weight of the supported equipment and the connected systems and components.
- E. Shop Drawings:
 - 1. Submit Shop Drawings for the trapeze hangers, steel slotted channel systems, nonmetallic slotted channel systems, and equipment supports proposed for the Work of this Section to the Program/Project Manager for approval.
 - a. Submit Product Data for the components of each item.
 - b. Show fabrication and installation details.
 - c. Include calculations.
 - d. Have the Shop Drawings signed and sealed by a qualified Professional Engineer.

2.03 SYSTEMS

- A. Steel Slotted Support Systems:
 - 1. Provide factory-fabricated hanger and support components for field assembly complying with the requirements specified in MFMA-4.
 - 2. Metallic Coatings:
 - a. If metallic coatings are indicated in the Contract Documents, hot-dip galvanize the components after fabrication in accordance with the requirements specified in MFMA-4.
 - 3. Nonmetallic Coatings:
 - a. If nonmetallic coatings are indicated in the Contract Documents, apply the manufacturer's standard PVC, polyurethane, or polyester coating applied in accordance with the requirements specified in MFMA-4.
 - 4. Painted Coatings:



- a. If painted coatings are indicated in the Contract Documents, apply the manufacturer's standard painted coating in accordance with the requirements specified in MFMA-4.
 5. Channel Dimensions:
 - a. Select channel dimensions to comply with the applicable load criteria.
 6. Manufacturers:
 - a. Allied Tube & Conduit, www.alliedtube.com.
 - b. B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
 - c. ERICO/Michigan Hanger Co., www.erico.com.
 - d. Thomas & Betts Corporation, www.tnb.com.
 - e. Unistrut Corp.; Tyco International, Ltd.; www.unistrut.com.
 - f. Wesanco, Inc., www.wesanco.com.
 - g. Approved equal.
 7. Submit Product Data for the steel slotted support systems proposed for the Work of this Section to the Program/Project Manager for approval.
- B. Nonmetallic Slotted Support Systems:
 1. Provide structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes in at least one surface spaced a maximum of 8 inches apart on center.
 2. Fittings and Accessories:
 - a. Provide products manufactured by the channel and angle manufacturer, and designed for use with those items.
 3. Rated Strength:
 - a. Provide components selected to comply with the applicable load criteria.
 4. Manufacturers:
 - a. Allied Tube & Conduit., www.alliedtube.com.
 - b. B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.
 - c. www.b-line.com.
 - d. Fabco Plastics Wholesale Limited., www.fabcoplastics.com.
 - e. Seasafe, Inc., www.seasafe.com.
 - f. Approved equal.
 5. Submit Product Data for the nonmetallic slotted support systems proposed for the Work of this Section to the Program/Project Manager for approval.
- C. Raceway and Cable Supports:
 1. Provide raceway and cable supports complying with the requirements specified in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices:
 1. Provide steel and malleable-iron hangers, clamps, and associated fittings, designed for the types and sizes of raceway or cable to be supported.



E. Support for Conductors in Vertical Conduit:

1. For non-armored electrical conductors or cables in riser conduits, provide a factory-fabricated assembly consisting of a threaded body and insulating wedging plug or plugs, or conduit riser grips, as required or indicated on the Contract Drawings.
 - a. Threaded Body and Wedging Plug(s):
 - 1) Provide plugs having a malleable iron body, and conductor gripping pieces of the number, size, and shape required to suit the conductors or cables supported.
 - 2) Manufacturers:
 - a) Producto Electric Corporation, Peco, www.pecoelect.com.
 - b) EGS Electrical Group, O-Z/Gedney Corporation, www.o-zgedney.com.
 - c) Approved equal.
 - b. Conduit Riser Grips:
 - 1) Provide ring type, double weave, tin coated bronze conduit riser grips sized as required to accommodate the number of conductors indicated on the Contract Drawings.
 - 2) Manufacturers:
 - a) Hubbell, Inc., Kellems® Wire Management Products, www.hubbell-wiring.com.
 - b) Leviton Manufacturing Company, Inc., www.leviton.com.
 - c) Approved equal.

F. Fabricated Metal Equipment Support Assemblies:

1. Shop- or field-fabricate metal equipment support assemblies by welding or bolting, structural-steel shapes to fit the dimensions of the equipment supported.
 - a. Provide steel shapes and plates complying with the requirements specified in Section 05500, Metal Fabrications.

2.04 MATERIALS:

A. Structural Steel for Fabricated Supports and Restraints:

1. Provide black and galvanized steel plates, shapes, and bars complying with the requirements specified in ASTM A 36/A 36M as required for the fabricated supports and restraints.

B. Concrete Inserts:

1. Provide steel or malleable-iron, slotted support system inserts complying with MFMA-4 or MSS SP-58, and similar to MSS SP-58 Type 18.

C. Concrete Materials:

1. Concrete Formwork:
 - a. Provide concrete formwork complying with the requirements specified in Section 03100, Concrete Forms and Accessories.



2. Concrete Reinforcing:
 - a. Provide concrete reinforcing complying with the requirements specified in Section 03200, Concrete Reinforcement.
3. Concrete:
 - a. Provide concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete.
- D. Clamps for Attachment to Steel Structural Elements:
 1. For attachment to steel structural elements, provide a type of clamp specified in MSS SP-58 as suitable for the attached structural element.
- E. Through Bolts:
 1. Provide hex head, high strength structural type bolts complying with the requirements specified in ASTM A 325.
- F. Toggle Bolts:
 1. Provide all-steel spring head type toggle bolts.
- G. Hanger Rods:
 1. Provide threaded steel hanger rods.
- H. Mounting, Anchoring, and Attachment Components:
 1. Provide the following items for fastening electrical items or their supports to building surfaces:
 - a. Powder-Actuated Fasteners:
 - 1) For use in hardened Portland cement concrete, steel, or wood, provide threaded-steel powder-actuated studs having tension, shear, and pullout capacities appropriate for the loads supported and the building materials in which the powder-actuated stud is used.
 - 2) Manufacturers:
 - a) Hilti, Inc., www.hilti.com.
 - b) ITW Ramset/Red Head, www.ramset-redhead.com.
 - c) MKT Fastening, LLC, <https://www.mktfastening.com/>.
 - d) Masterset Fastening Systems, Inc., www.simpsonanchors.com.
 - e) Approved equal.
 - b. Mechanical-Expansion Anchors:
 - 1) For use in hardened Portland cement concrete, provide insert-wedge-type, zinc-coated steel expansion anchors, with tension, shear, and pullout capacities appropriate for loads supported and the building materials in which the expansion anchor is used.
 - 2) Manufacturers:
 - a) B-Line Systems, Inc., a division of Cooper Industries; www.b-line.com.



- b) Empire Tool and Manufacturing Co., Inc.,
www.empiretool.com.
- c) Hilti, Inc.; www.hilti.com.
- d) ITW Ramset/Red Head, www.ramset-redhead.com.
- e) MKT Fastening, LLC, <https://www.mktfastening.com/>.
- f) Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the locations to receive electrical hangers and supports.
- B. Evaluation and Assessment:
 - 1. Verify that the locations to receive electrical hangers and supports are ready for the Work of this Section.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect areas surrounding the locations to receive electrical hangers and supports from damage resulting from installation of the hangers and supports.
 - 2. Protect adjacent areas from weld spatter and paint stains.

3.03 INSTALLATION

- A. Installing Hangers and Supports:
 - 1. Comply with NECA 1 and NECA 101 requirements for installing hangers and supports for electrical equipment and systems except as otherwise specified.
 - a. If the requirements specified in this Section are stricter, comply with the stricter requirements.
 - 2. Raceway and Cable Support Methods:
 - a. Maximum Support Spacing for Raceway:
 - 1) Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where Table 1.
 - a) In addition to the methods specified in NECA 1, NFPA 70 permits EMT, IMC, and RMC to be supported by openings through structure members.
 - b. Minimum Hanger Rod Size for Raceway:
 - 1) Provide a minimum rod size of 1/4 inch in diameter.
 - c. Multiple Raceways or Cables:
 - 1) For multiple raceways or cables, install trapeze-type supports fabricated from steel slotted support system components sized so



- the capacity can be increased by at least 25 percent in the future without exceeding the specified design load limits.
- 2) Secure raceways and cables to the supports with two-bolt conduit clamps.
 - d. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
3. Strength of Support Assemblies:
 - a. Where the sizes of components are not indicated, select component sizes so their strength will be adequate to carry present and future static loads within the specified loading limits.
 - b. Use a minimum static design load for determining the strength of support assemblies consisting of the weight of the supported components plus 200 pounds.
 4. Mounting and Anchorage of Surface-Mounted Equipment and Components:
 - a. Anchor and fasten electrical items and their supports to the building structural elements using the following methods unless otherwise indicated by Code:
 - 1) For surface mounting equipment and components on wood, provide lag screws or through bolts.
 - 2) For surface mounting equipment and components on new concrete, provide concrete inserts and bolts.
 - 3) For surface mounting equipment and components on masonry, provide approved toggle-type bolts on hollow masonry units, and expansion anchor fasteners on solid masonry units.
 - 4) For surface mounting equipment and components on existing concrete, provide expansion anchor fasteners.
 - a) In lieu of expansion anchors, powder-actuated driven threaded studs with lock washers and nuts may be provided in existing standard-weight concrete 4 inches or more thick.
 - (1) Do not use powder-actuated driven threaded studs for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 5) For surface mounting equipment and components on steel, provide beam clamps complying with the requirements specified in MSS SP-69 (MSS Types 19, 21, 23, 25, or 27).
 - 6) For surface mounting equipment and components on light steel, provide sheet metal screws.
 - 7) For surface mounting equipment and components on hollow walls and nonstructural building surfaces, provide slotted-channel racks attached to the substrate by means that meet seismic-restraint strength and anchorage requirements.



- a) Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks.
5. When drilling holes for expansion anchors in concrete, select locations and depths that avoid reinforcing bars.
- B. Installing Fabricated Metal Supports:
 1. For site-fabricated metal supports, comply with the installation requirements specified in Section 05500, Metal Fabrications.
 2. Cut, fit, and place miscellaneous metal supports accurately in the proper location, alignment, and elevation to support and anchor the electrical materials and equipment.
 3. Perform field welding in accordance with the requirements specified in, AWS D1.1/D1.1M.
- C. Constructing Concrete Bases:
 1. Construct concrete bases of the dimensions indicated in the Contract Documents, but not less than 4 inches larger in both directions than the supported unit, and so anchors will be a minimum of 10 bolt diameters from the edge of the base.
 2. Unless otherwise noted on the Contract Drawings, provide concrete having a 28-day compressive-strength of 3000 psi.
 3. Anchor equipment to the concrete base.
 - a. Place and secure anchorage devices.
 - 1) Furnish the supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions with the items to be embedded.
 - b. Install anchor bolts to the elevations required for proper attachment to supported equipment.
 - c. Install anchor bolts according to the anchor-bolt manufacturer's written instructions.

3.04 REPAIR/RESTORATION

- A. Touchup Painting:
 1. Clean field welds and abraded areas of shop paint.
 2. Paint exposed areas immediately after erecting hangers and supports using the same materials as used for shop painting.
 - a. Comply with the requirements specified in SSPC-PA 1 for touching up field-painted surfaces.
 3. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup Painting:



1. Comply with requirements specified in Section 09912, Painting, for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces:
1. Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint in accordance with the requirements specified in ASTM A 780.

END OF SECTION



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0	10/06/2017	N/A	All	First edition.



SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for identification of electrical components, including raceways, cables and conductors, and equipment.
 - 2. Requirements for warning labels and signs, including both above- and underground applications.
 - 3. Requirements for electrical instruction signs and other miscellaneous identification products.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 09912 - Painting.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. NRTL: Nationally recognized testing agency.
 - 2. UPS: Uninterrupted power system.
 - 3. UV: Ultra violet radiation.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
 - 3. UV-Stabilized: Formulated so ultra violet radiation does not degrade the material so stabilized; generally required for materials susceptible to such degradation that are continuously exposed to exterior sunlight.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
 - 2. American National Standards Institute (ANSI).



- a. ANSI A13.1 – American National Standard Scheme for the Identification of Piping Systems.
 - b. ANSI Z535.1 - American National Standard Safety Color Code.
 - c. ANSI Z535.3 - American National Standard Criteria for Safety Symbols.
 - d. ANSI Z535.4 - American National Standard Product Safety Signs and Labels.
 - e. ANSI 535.5 - American National Standard Accident Prevention Tags.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. Institute of Electrical and Electronics Engineers (IEEE):
 - a. ANSI/IEEE C2 – National Electrical Safety Code.
6. National Fire Protection Association (NFPA).
 - a. NFPA 70 – National Electrical Code.
7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
8. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
 - 2) 29 CFR 1926 Safety and Health Regulations for Construction.
9. Underwriters Laboratory (UL):
 - a. UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - b. UL 969 – Standard for Marking and Labeling Systems

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, the Contract Drawings, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manuals; and with those required by codes, standards, and OSHA 29 CFR 1910.145.
 - a. Use consistent designations throughout Work of this Contract.
 2. Coordinate the installation of identifying devices with the location of access panels and doors.
- B. Sequencing:
 1. Install identifying devices before installing acoustical ceilings and similar concealment.
 2. Coordinate the installation of identifying devices with the completion of covering and painting surfaces where the devices are to be applied.



- a. Apply identification devices to surfaces that require a finish after completing the finish work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Power raceway identification materials.
 - 2) Power and control cable identification materials.
 - 3) Conductor identification materials.
 - 4) Floor marking tape.
 - 5) Underground line warning tape.
 - 6) Warning labels and signs.
 - 7) Instruction signs.
 - 8) Equipment identification labels.
 - 9) Cable ties.
 - 10) Paint.
 - 11) Fasteners.
 - b. Samples:
 - 1) Samples of each type of label and sign.
 - c. Delegated Design Submittals:
 - 1) Index of Nomenclature of Electrical Equipment and System Components.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Site Samples:

1. To illustrate the size, colors, lettering style, mounting provisions, and graphic features of identification products, submit Samples of each type of label and sign to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

A. Manufacturers:

1. Substitution Limitations:
 - a. Provide the standard products of a manufacturer regularly engaged in the manufacture of electrical identification products.



2. Product Options:
 - a. Product Data:
 - 1) Submit manufacturers Product Data for the electrical identification products proposed for the Work of this Section to the Program/Project Manager for approval.
- B. Regulatory Requirements:
 1. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work of this Section, including among others the following:
 - a. Phoenix Building Construction Code and Amendments.
- C. Design Criteria:
 1. Design the electrical identification system for this Contract in accordance with the requirements specified in the following codes, regulations, and standards:
 - a. ANSI A13.1 for pipe identification.
 - b. ANSI/IEEE C2, the National Electrical Safety Code.
 - c. ANSI Z535.4 for safety signs and labels.
 - d. NFPA 70, the National Electric Code.
 - e. OSHA 29 CFR 1910.144, "Safety Color Code for Marking Physical Hazards", and 29 CFR 1910.145 "Specifications for Accident Preventions Signs and Tags".
 2. Index of Nomenclature of Electrical Equipment and System Components:
 - a. Prepare an Index of Nomenclature of Electrical Equipment and System Components listing all of the nomenclature used in identification signs and labels.
 - b. Submit the Index of Nomenclature of Electrical Equipment and System Components to the Program/Project Manager for approval.
- D. Materials:
 1. Power Raceway Identification Materials:
 - a. Legends:
 - 1) Provide letters for legends with the minimum sizes and color field lengths in accordance with the requirements specified in ANSI A13.1 for each raceway size.
 - 2) For raceways carrying circuits at 600 Volts or less, provide white letters on a black field.
 - a) Indicate the voltage in the legend.
 - b. For raceways carrying circuits at 600 V or less, provide one of the following:
 - 1) Self-Adhesive Vinyl Labels:
 - a) Provide preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating, and having a matching wraparound adhesive tape for securing the ends of the legend label.



- b) Provide adhesive-attached labeling materials, including the label stocks, laminating adhesives, and inks used by label printers, complying with the requirements specified in UL 969.
 - 2) Snap-Around Labels:
 - a) Provide slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with a diameter sized to suit the diameter of the raceway or cable it identifies, and designed to stay in place by the gripping action of the sleeve.
 - 3) Snap-Around, Color-Coding Bands:
 - a) Provide slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with a diameter sized to suit the diameter of the raceway or cable it identifies, and to stay in place by the gripping action of the sleeve.
 - b) Marker for Tags:
 - (1) Provide the permanent, waterproof, black ink marker recommended by the tag manufacturer.
 - c) Marker for Tags:
 - (1) Provide the machine-printed, permanent, waterproof, black ink marker recommended by the printer manufacturer.
- 2. Power and Control Cable Identification Materials:
 - a. Legends:
 - 1) Provide letters for legends with the minimum sizes and color field lengths in accordance with the requirements specified in ANSI A13.1 for each raceway size.
 - b. Self-Adhesive Vinyl Labels:
 - 1) Provide preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating, and having matching wraparound adhesive tape for securing the ends of the legend label.
 - 2) Provide adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, complying with the requirements specified in UL 969.
 - c. Snap-Around Labels:
 - 1) Provide slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with a diameter sized to suit the diameter of the raceway or cable it identifies, and designed to stay in place by the gripping action of the sleeve.
 - d. Snap-Around, Color-Coding Bands:
 - 1) Provide slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with a diameter sized to suit the diameter of the raceway or cable it identifies, and to stay in place by the gripping action of the sleeve.
- 3. Conductor Identification Materials:
 - a. Color-Coding Conductor Tape:
 - 1) Provide color-coded, self-adhesive vinyl conductor tape not less than 3 mils thick by 1 to 2 inches wide.



- b. Self-Adhesive Vinyl Labels:
 - 1) Provide preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating, and having matching wraparound adhesive tape for securing the ends of the legend label.
 - 2) Provide adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, complying with the requirements specified in UL 969.
- c. Snap-Around Labels:
 - 1) Provide slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with a diameter sized to suit the diameter of the raceway or cable it identifies, and designed to stay in place by the gripping action of the sleeve.
- d. Snap-Around, Color-Coding Bands:
 - 1) Provide slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with a diameter sized to suit the diameter of the raceway or cable it identifies, and to stay in place by the gripping action of the sleeve.
- e. Marker Tapes:
 - 1) Provide vinyl or vinyl-cloth, self-adhesive wraparound type tape, with a circuit identification legend machine printed onto the tape by thermal transfer or an equivalent process.
- 4. Floor Marking Tape:
 - a. For marking floors, provide 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and a clear vinyl overlay.
- 5. Underground Line Warning Tape:
 - a. Tape:
 - 1) Provide tape recommended by the manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2) Provide chemically inert tape and ink materials not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - a) Print permanent legends on the tape that will not be damaged by burial operations.
 - 3) Provide tape colors and inscriptions complying with the requirements of ANSI Z535.1, ANSI Z535.3, ANSI Z535.4, and ANSI 535.5.
 - a) Red-Colored Tape Inscriptions:
 - (1) ELECTRIC LINE.
 - (2) HIGH VOLTAGE.
 - b) Orange-Colored Tape Inscriptions:
 - (1) TELEPHONE CABLE.
 - (2) CATV CABLE.
 - (3) COMMUNICATIONS CABLE.
 - (4) OPTICAL FIBER CABLE.
- 6. Warning Labels and Signs:



- a. Provide preprinted baked-enamel aluminum warning labels and signs, having the colors, legend, and size required for the application in accordance with the requirements specified in NFPA 70 and 29 CFR 1910.145, 145 "Specifications for Accident Prevention Signs and Tags".
 - 1) For mounting, punch or drill the warning labels and signs for fasteners in the corners, and install 1/4-inch grommets.
 - 2) Provide warning labels and signs having a nominal size of 7 inches by 10 inches.
 - b. Legends:
 - 1) Warning label and sign legends include, but are not limited to, the following:
 - a) Multiple Power Source Warning:
 - (1) DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES.
 - b) Workspace Clearance Warning:
 - (1) WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES.
7. Instruction Signs:
- a. Provide engraved, laminated acrylic or melamine plastic instruction signs, a minimum of 1/16 inch thick for signs up to 20 square inches and 1/8 inch thick for larger sizes.
 - b. Frame the instruction signs with a mitered acrylic molding, and punched or drilled for mechanical fasteners arranged for attachment at applicable equipment.
 - c. Legend:
 - 1) Provide an engraved legend with black letters on a white face.
8. Equipment Identification Labels:
- a. Provide self-adhesive, engraved, laminated acrylic or melamine labels having white letters a minimum of 3/8 inch high on a dark-gray background.
9. Cable Ties:
- a. General-Purpose Cable Ties:
 - 1) Provide one piece, fungus inert, self-extinguishing, self-locking, Type 6/6 nylon cable ties.
 - a) Minimum Width: 3/16 inch.
 - b) Tensile Strength: 12,000 psi at 73 degrees Fahrenheit when measured in accordance with the requirements specified in ASTM D 638.
 - c) Temperature Range: Minus 40 to plus 185 degrees Fahrenheit.
 - d) Color: Black, except where used for color-coding.
 - b. UV-Stabilized Cable Ties:



- 1) Provide one piece, fungus inert, self-extinguishing, self-locking, Type 6/6 nylon cable ties designed for continuous exposure to exterior sunlight.
 - a) Minimum Width: 3/16 inch.
 - b) Tensile Strength: 12,000 psi at 73 degrees Fahrenheit when measured in accordance with the requirements specified in ASTM D 638.
 - c) Temperature Range: Minus 40 to plus 185 degrees Fahrenheit.
 - d) Color: Black.
- c. Plenum-Rated Cable Ties:
 - 1) Provide one piece, self-extinguishing, self-locking, cable ties designed for continuous exposure to exterior sunlight.
 - a) Minimum Width: 3/16 inch.
 - b) Tensile Strength: 7000 psi at 73 degrees Fahrenheit when measured in accordance with the requirements specified in ASTM D 638.
 - c) Temperature Range: Minus 50 to plus 284 degrees Fahrenheit.
 - d) Flame Rating: 94V-0 when measured in accordance with the requirements specified in UL 94.
 - e) Color: Black.

2.02 ACCESSORIES

- A. Paint:
 1. Provide paint materials complying with the requirements specified in Section 09912, Painting.
 2. Select the paint system applicable for the surface material and location, either exterior or interior.
- B. Fasteners:
 1. Provide self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers for labels and signs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Verify the identity of each item before installing identification products.

3.02 PREPARATION

- A. Surface Preparation:
 1. Self-Adhesive Identification Products:



- a. Before applying self-adhesive identification products, clean the surfaces where the identification device is to be applied using materials and methods recommended by the manufacturer of identification device.

3.03 INSTALLATION

- A. Location:
 1. Install identification materials and devices at locations most convenient for viewing the identification device without interference with the operation and maintenance of equipment.
- B. Self-Adhesive and Non-Adhesive Identification Products:
 1. Attach self-adhesive identification products after properly cleaning the surface.
 2. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- C. System Identification Color-Coding Bands for Raceways and Cables:
 1. Ensure that each color-coding band completely encircles the cable or conduit.
 2. Place adjacent bands of two-color markings in contact, side by side.
 3. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Cable Ties:
 1. For attaching tags, provide general-purpose type cable ties, except as follows:
 - a. For outdoor applications, provide UV-stabilized nylon cable ties.
 - b. For spaces handling environmental air, provide plenum rated cable ties.
- E. Underground-Line Warning Tape:
 1. During trench backfilling, install continuous underground-line warning tape directly above line at an elevation 6 to 8 inches below the finished grade.
 2. Use multiple tapes where the width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- F. Painted Identification:
 1. For surface preparation and paint application requirements, comply with the requirements specified in Section 09912, Painting.

3.04 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to Ground:



1. Identify accessible raceways and metal-clad cables, 600 V or less, for service, feeder, and branch circuits more than 30A, and 120V to ground with self-adhesive vinyl labels installed at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings:
 1. Identify the covers of each junction and pull box of the emergency power, power, and uninterrupted power systems with self-adhesive vinyl labels having the system voltage and the following wiring system legend as appropriate:
 - a. Emergency Power.
 - b. Power.
 - c. UPS.
- C. Power-Circuit Conductor 600 V or Less:
 1. For 600 V or less power-circuit conductors in vaults, pull and junction boxes, manholes, and handholes, provide color-coding conductor tape to identify the phase.
 - a. Factory-apply the color to the tape, or if the Authorities Having Jurisdiction permit, field-apply the color for sizes larger than 8 AWG.
 - 1) Field-Applied, Color-Coding Conductor Tape:
 - a) Apply field-applied, color-coding conductor tape in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made.
 - b) Apply the last 2 turns of tape with no tension to prevent possible unwinding.
 - c) Locate the bands so factory cable markings are not obscured.
 2. For color-coding the phase and voltage level for 600 V or less ungrounded service feeder and branch-circuit conductors, provide the following colors:
 - a. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
- D. Power-Circuit Conductor Greater than 600 V:
 1. For power-circuit conductor greater than 600 V in vaults, pull and junction boxes, manholes, and handholes, provide nonmetallic plastic tag holders with adhesive-backed phase tags, and separate tags with the circuit designation.
- E. Conductors to Be Extended in the Future:
 1. For conductors to be extended in the future, attach write-on tags to the conductors and list the source.



- F. Auxiliary Electrical Systems Conductors:
 - 1. Identify field-installed alarm, control, and signal connections.
 - 2. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points.
 - a. Provide identification by system and circuit designation.
 - 3. Provide a system of marker tape designations that is uniform and consistent with the system used by the manufacturer for factory-installed connections.
 - 4. Coordinate identification with the Contract Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines:
 - 1. For power, lighting, communication, and control wiring, and for optical fiber cable, provide underground-line warning tape.
 - 2. Provide underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication:
 - 1. Provide floor marking tape to show the working clearances in the direction of access to live parts.
 - 2. Unless otherwise indicated, the workspaces and working clearances are as specified in NFPA 70 and 29 CFR 1926.403(i)(1), "Working Space about Electrical Equipment".
 - 3. Do not provide floor marking tape at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures:
 - 1. For indoor cabinets, boxes, and enclosures for power and lighting, provide baked-enamel warning signs and labels complying with the requirements specified in 29 CFR 1910.145, "Specifications for Accident Prevention Signs and Tags".
 - a. Identify system voltage with black letters on an orange background.
 - 2. Apply the warning signs and labels to the exterior of doors, covers, or other access means.
 - 3. For equipment with multiple power or control sources including, but not limited to, the following, apply the warning signs and labels to the door or cover of the equipment:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs:
 - 1. To facilitate proper operation and maintenance of electrical systems and the items to which they connect, provide instruction signs.
 - 2. Where instructions are needed for system or equipment operation, provide instruction signs with an approved legend.



- K. Emergency Operating Instruction Signs:
 - 1. For emergency instructions at equipment used for power transfer, provide instruction signs with a white legend on a red background with minimum 3/8-inch-high letters.
- L. Equipment Identification Labels:
 - 1. On each unit of equipment, provide a unique label designation consistent with the wiring diagrams, schedules, and the Operation and Maintenance Manual.
 - a. Unless the equipment is provided with its own identification, provide labels for the power, lighting, control, communication, signal, monitoring, and alarm systems.
 - b. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and the racks for each system.
 - 2. Labeling Instructions:
 - a. Indoor Equipment:
 - 1) Provide self-adhesive, engraved, laminated acrylic or melamine labels.
 - 2) Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on a 1-1/2-inch high label; if two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment:
 - 1) Provide engraved, laminated acrylic or melamine labels.
 - c. Elevated Components:
 - 1) Increase the sizes of labels and letters to those appropriate for recognition of the information from the floor.
 - d. Unless the labels are self-adhesive, fasten the labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure as specified in NEMA 250 or other applicable NRTL standards.
 - 3. Equipment to Be Labeled:
 - a. Individual Sections or NFPA 70 may require labeling the following items:
 - 1) Panelboards:
 - a) Provide a typewritten directory of the circuits in the location provided by the panelboard manufacturer.
 - b) Provide self-adhesive, engraved, laminated acrylic or melamine labels to identify panelboards.
 - 2) Enclosures and electrical cabinets.
 - 3) Access doors and panels for concealed electrical items.
 - 4) Switchboards.
 - 5) Transformers:
 - a) Provide a label that includes the tag designation shown on the Contract Drawings for the transformer, feeder, and panelboards, or equipment supplied by the secondary.



- 6) Emergency system boxes and enclosures.
- 7) Motor-control centers.
- 8) Enclosed switches.
- 9) Enclosed circuit breakers.
- 10) Enclosed controllers.
- 11) Push-button stations.
- 12) Power transfer equipment.
- 13) Contactors.
- 14) Remote-controlled switches, dimmer modules, and control devices.
- 15) Battery-inverter units.
- 16) Battery racks.
- 17) Monitoring and control equipment.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16076

COMMUNICATIONS IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing identifying labels for communications backbone, riser, and horizontal cabling.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CAAN: Capital Asset Account Number.
 - 2. CFN: Consecutive Fiber Numbering sequence.
 - 3. HH: Handhole(s).
 - 4. IDF: Intermediate Distribution Frame.
 - 5. MDF: Main Distribution Frame.
 - 6. MH: Maintenance holes or manholes.
 - 7. PVC: Polyvinyl Chloride.
 - 8. RPP: Reverse Pair Positioning.
 - 9. TSB: Technical Systems Bulletin.
- B. Definitions:
 - 1. Multimode Optical Fiber: An optical fiber that carries only many paths of light.
 - 2. Singlemode Optical Fiber: An optical fiber that carries only one path of light.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
 - 3. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - 4. Telecommunications Industry Association (TIA):



- a. ANSI/TIA-606-A – Administrative Standard for Commercial Telecommunications Infrastructure.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Communication identification products.
 - b. Qualification Statements:
 - 1) Communication identification installer's qualifications.

1.04 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 - 1. Communication Identification Installer's Qualifications:
 - a. Employ an installation team certified by the manufacturer as having completed the necessary training to complete their part of the installation.
 - b. Submit resumes for the entire team, including documentation of completed training courses.

PART 2 PRODUCTS

2.01 LABELS

- A. Manufacturers:
 - 1. Substitution Limitations:
 - a. Comply with the substitution requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 2. Product Options:
 - a. Comply with the product option requirements specified in Section 16702, Basic Communications Materials and Methods.
- B. Design Criteria:
 - 1. Comply with the requirements specified in the PSHIA Premises Distribution System Standards.
 - 2. Provide labeling complying with the requirements specified herein and, where applicable, with the requirements specified in ANSI/TIA-606-A.



- a. Submit Product Data for the communication identification products proposed for the Work of this Section to the Program/Project Manager for approval.
- 3. Conflicts
 - a. If conflicts between referenced requirements arise, comply with the one establishing the more stringent requirements.
 - b. If conflicts between referenced requirements and the Contract Documents arise, comply with the one establishing the more stringent requirements.

C. Materials:

- 1. Fiber Optic Cable Labels:
 - a. Provide fiber optic cable labels consisting of either a stainless steel or a plastic type tag with a steel or plastic tie wrap for attaching the label to the cable.
 - 1) If plastic labels are provided, provide yellow and black labels having a self-laminating cover for use with pre-printed labels.
 - b. Provide tags and tie wraps approved for both interior and exterior use.
 - 1) For indoor use, provide white tie wraps.
 - 2) For outdoor use, provide black tie wraps.
 - c. Provide riser rated labels and tie wraps where required.
 - d. Manufacturers:
 - 1) Panduit, Type PST-FO, self-laminating, GMV4 Rigid Vinyl, www.panduit.com.
 - 2) Approved equal.
- 2. Fiber Optic Warning Tags:
 - a. Provide polyvinyl chloride (PVC) fiber optic warning tags capable of being snapped onto the cable sheath.
 - b. Provide orange fiber optic warning tags with large black letters.
 - c. Manufacturers:
 - 1) Panduit, Type PCV-FOR, www.panduit.com.
 - 2) Approved equal.
- 3. Fiber Optic Termination Housing Labels:
 - a. Provide one piece, full size, laser printable, self-adhesive label sheets capable of being adhered to the plastic panel provided by the termination housing manufacturer on the inside of the enclosure door.
 - 1) Cut the label sheet to 8.5-inch by 11-inch size.
 - b. Furnish a laser printer, and print the labels in a black 10 point, Helvetica font on a color-coded background sheet, or an approved equivalent.
 - 1) For singlemode optical fiber labels, provide yellow background sheets.
 - 2) For multimode optical fiber labels, provide orange background sheets.
- 4. Copper Cable Termination Housing Labels:



- a. Furnish an electronic label maker to produce labels for the terminals, printed in black on a white background, using a 10 point, Helvetica font, or an approved equivalent.
5. Copper Cable Labels:
 - a. Provide copper cable labels consisting of either a stainless steel or a plastic type tag with a steel or plastic tie wrap for attaching the label to the cable.
 - 1) If plastic labels are provided, provide grey labels having a write on surface.
 - b. Provide tags and tie wraps approved for both interior and exterior use.
 - 1) For indoor use, provide white tie wraps.
 - 2) For outdoor use, provide black tie wraps.
 - c. Provide riser rated labels and tie wraps where required.
 - d. Manufacturers:
 - 1) Panduit, Type CM4S-L8, www.panduit.com.
 - 2) Approved equal.

PART 3 EXECUTION

3.01 APPLICATION

- A. Cable Labeling:
 1. Provide cable labels as indicated on the Contract Drawings, and on the following:
 - a. Jack face plates.
 - b. Cables inside back boxes, junction boxes, access points, and manholes/handholes.
 - c. Cables above the terminations in the Intermediate Distribution Frame (IDF) and Main Distribution Frame (MDF).
 - d. Patch panels, and when the cable is not in conduit every 50 feet on the cable.
- B. Conduit Labeling:
 1. Label conduit every 50 feet, and at the origination and destination of the conduit.
- C. Fiber Optic Cable Termination Cabinet/Housing Labeling:
 1. Label fiber optic termination housings inside the enclosure door by adhering a label sheet to the plastic panel provided by the termination housing manufacturer.
 2. Always place the panels for the singlemode optical fiber housing connector first and to the immediate left hand side of the housing, then place the multimode optical fiber connector panels.
 - a. Apply this sequence to both singlemode and multimode strands in the same cable (Hybrid), or in separate cables.



- b. In wall-mounted housings, always place the singlemode optical fiber connectors in the very topmost position, followed by the multimode optical fiber connectors.
3. In each terminal housing, provide only one labeling sheet to identify the fiber optic strands.
 - a. Do not provide multiple labels on a single door.
4. Provide housing labels containing the Capital Asset Account Number (CAAN) for the building (Source) where the fiber optic cable originates, the CAAN for the building (Destination) where the fiber optic strands terminate and the MDF/IDF identification number where the Destination housing is located.
5. Number the fiber strands consistent with the Consecutive Fiber Numbering (CFN) sequence identified in ANSI/TIA/EIA-568-B.1.
 - a. Provide this fiber strand numbering sequence at each terminated end of the fiber optic cable.
 - b. Do not roll fiber optic strands, a procedure identified in ANSI/TIA/EIA-568-B.1 as Reverse Pair Positioning (RPP).
6. Label fiber optic housings containing vertical connector panels as follows:
 - a. Label the fiber strand occupying fiber port number 1 in the upper most left position of the first duplex bulkhead connector installed in the connector panel placed in the first slot on the left side of the housing as fiber strand number 1 (Blue).
 - b. Label the fiber strand occupying fiber port number 2 of the same duplex bulkhead connector installed in the connector panel as fiber strand number 2 (Orange).
 - 1) This number 2 port is located to the immediate right of fiber port number 1.
 - c. Number the remaining fiber optic strands consecutively left to right, and top to bottom.
7. Label fiber optic housings containing horizontal connector panels as follows:
 - a. Label the fiber strand occupying fiber port number 1 in the uppermost top left position of the first duplex bulkhead connector installed in the connector panel placed in the upper most left slot of the housing as fiber strand number 1 (Blue).
 - b. Label the fiber strand occupying fiber port number 2 of the same duplex bulkhead connector installed in the connector panel as fiber strand number 2 (Orange).
 - 1) The number 2 port is located immediately below fiber port number 1.
 - c. Number the remaining fiber optic strands consecutively left to right, and top to bottom.
8. Fiber Optic Splice Shelf Labeling:
 - a. Label fiber optic splice shelves and drawers sequentially from top to bottom.



- b. Identify the fiber splices using an adhesive backed single sheet of labeling stock printed using a laser printer, and trimmed to fit the inside door of the splice shelf.
- c. Identify the splice tray, position number, and the fiber strand spliced at that location in tabular form.
- d. Include the cable number, the fiber optic strand number, and the strand type.

D. Fiber Optic Cable Sheath Labeling:

- 1. As a minimum, label the sheathes of fiber optic cables located inside buildings within 12 inches of the fiber termination housing, the point at which the cable enters and/or exits the room, and at one mid-point location when the cable is installed in a cable tray or ladder.
 - a. Provide fiber optic cable sheath labels containing the cable type, total strand count of the cable, the origination and destination Capital Asset Account Numbers (CAAN), Rack, Panel, and Fiber Count.
 - b. Additional sheath labels may be installed at the request of the Program/Project Manager.
- 2. Label the sheaths of fiber optic cables located in maintenance holes (MH) and handholes (HH) in at least one location that is visible from grade level.
 - a. Label maintenance holes (MH) and handholes (HH) containing splice closures on each side of the splice closure in a location visible from grade level.
- 3. In manholes and handholes that contain a splice, attach labels to each cable in the fiber optic cable sheath.
 - a. In manhole/handhole units, provide a minimum of 2 labels, or 3 labels if the path crosses multiple manholes/handholes, with the following:
 - 1) For Label 1, indicate the Manhole/Handhole Origination > Fiber Type/Origination Capital Asset Account Number (CAAN) / Rack / Panel / Fiber Count.
 - 2) For Label 2, indicate the Fiber Type/Origination Capital Asset Account Number (CAAN) / Rack / Panel / Fiber Count > Fiber Type / Destination Capital Asset Account Number (CAAN) / Rack / Panel / Fiber Count.
 - 3) For Label 3, indicate the Manhole Origination > Manhole Destination (if applicable).
 - b. If the path crosses multiple manholes/handholes, provide a minimum of 3 labels.

E. Copper Cable Termination Housing Labeling:

- 1. Label building entrance terminals with the name of the building, the building Capital Asset Account Number (CAAN), the cable pair numbers entering the terminal, and the cable pair number exiting the terminal (if applicable).
- 2. Place the labels on the wall above the terminal housing.
 - a. Do not label the terminal housing itself.



F. Copper Cable Sheath Labeling

1. As a minimum, label the sheathes of copper cables located inside buildings within 12 inches of the copper termination block, the point at which the cable enters and/or exits the room, and at one mid-point location when the cable is installed in a cable tray or ladder.
 - a. Additional sheath labels may be installed at the request of Program/Project Manager.
2. Label the sheaths of copper cables located in manholes (MH) and handholes (HH) in at least one location that is visible from grade level.
 - a. Label maintenance holes (MH) and handholes (HH) containing splice closures on each side of the splice closure in a location visible from grade level.
3. On the copper cable sheath labels, indicate the type of cable, the cable number, the cable pair count, and if applicable the number of dead cable pairs.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16080

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for acceptance testing of the new and modified electrical system, wiring, equipment, and grounding as indicated in the Contract Documents.
- B. Related Requirements:
 - 1. Section 01330 – Submittals.

1.02 REFERENCE STANDARDS:

- A. InterNational Electrical Testing Association (NETA):
 - 1. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 2. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
- B. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - 1. NICET Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and/or perform the required testing performed by the Electrical Testing Laboratory (ETL), the Approved Agency, and the City of Phoenix, prior to incorporating items requiring testing by them into the Work.
- B. Sequencing:
 - 1. Equipment Electrical Testing Schedule:
 - a. Prior to performing electrical testing, prepare an Equipment Testing Schedule indicating the equipment to be tested, test equipment to be used, and the sequence of the tests.
 - b. Submit the Equipment Testing Schedule to the Program/Project manager for approval.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Delegated Design Submittals:
 - 1) Equipment Electrical Testing Schedule.
 - b. Special Procedure Submittals:
 - 1) Tests Data Forms.
 - c. Qualification Statements:
 - 1) Electrical Testing Laboratory (ETL) qualifications:
 - 2) Electrical Testing Laboratory's Field Supervisor's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Field Verification Reports.
 - b. Manufacturer's Instructions:
 - 1) Manufacturer's installation, operation, and starting instructions for the equipment and systems to be tested.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.

B. Qualifications:

1. Electrical Testing Laboratory (ETL) Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City



- of Phoenix, employ a member company of the InterNational Electrical Testing Association (NETA) or an independent nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 having the experience and capability to conduct the testing required, not affiliated with the equipment manufacturer, and acceptable to the Authorities Having Jurisdiction.
- b. Submit the qualifications of the Electrical Testing Laboratory (ETL) to the Program/Project Manager for approval.
2. Electrical Testing Laboratory's Field Supervisor's Qualifications:
- a. To supervise the onsite testing specified, designate a person to be the Electrical Testing Laboratory's Field Supervisor who is currently certified by the InterNational Electrical Testing Association (NETA) in accordance with the requirements specified in ANSI/NETA ETT or the National Institute for Certification in Engineering Technologies (NICET) in accordance with the requirements specified in the NICET Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
 - b. Submit the qualifications of the Electrical Testing Laboratory's Field Supervisor to the Program/Project Manager for approval.
3. The Electrical Testing Laboratory (ETL) or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used and/or the qualifications of the firm and personnel.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify the correctness of the wiring by visually comparing the conductor connections with the connection diagrams.
 - a. Note or indicate wiring deviations from the wiring indicated in the Contract Documents.
 - b. Note any damage, missing parts, or incomplete work.
- B. Pre-Installation Testing:
 - 1. Verify that the electrical Work to be tested is free from improper grounds, short circuits, and overloads.
 - 2. Perform individual circuit continuity checks by using electrical circuit testers.
- C. Evaluation and Assessment:



1. Only begin acceptance testing after the verification of conditions and the correction of non-conformances affecting the testing have been completed.
 - a. Record the dates on which corrective actions to remedy non-conformances are completed, and revise the Equipment Electrical Testing Schedule if necessary.

3.02 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:

- a. During the installation of electrical equipment, the Electrical Testing Laboratory (ETL) and the code-required Approved Agency must perform routine and other testing.
 - 1) Advise the Electrical Testing Laboratory (ETL) and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
- b. Have all of the electrical testing performed witnessed by the Program/Project Manager.
- c. The Electrical Testing Laboratory (ETL) and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - 1) Inspections and testing performed exclusively for the convenience of the Contractor are the sole responsibility of the Contractor.
- d. Failure of the Electrical Testing Laboratory (ETL) or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.

2. Acceptance Testing:

- a. Have the Electrical Testing Laboratory (ETL) perform the acceptance testing and verification specified herein.
 - 1) Furnish termination and test equipment calibrated in accordance with the traceability requirements of the National Institute of Standards and Testing (NIST).
 - a) Submit a copy of the termination and test equipment calibration documents, and certification that the equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
 - 2) Test the electrical equipment provided under this Contract, including electrical distribution equipment and grounding.
 - 3) Test motorized equipment for acceptance and to verify conformance with the requirements of the Contract Documents.



- b. Tests Data Forms:
 - 1) Prior to performing electrical testing, prepare Tests Data Forms for recording the test results.
 - 2) Submit the Tests Data Forms to the Program/Project Manager for approval.
- c. Test Procedure:
 - 1) Perform the electrical testing in accordance with NETA standards.
 - a) Perform testing to assure that electrical equipment specified to be tested will operate within both industry and the manufacturer's published tolerances, and will perform safely.
 - 2) Conduct the three-point Fall of Potential ground test in accordance with IEEE 142 by using equipment from one of the following:
 - a) Megger®, www.biddlemegger.com
 - b) Associated Research, www.asresearch.com
 - c) Approved equal.
 - 3) Field Verification Reports:
 - a) Record test result data to be used as a baseline for future tests and maintenance.
 - b) After each inspection and test and within one week of the completion of each test, promptly submit a certified copy of a field verification report to the Program/Project Manager for information.
 - c) Include the following in each report:
 - (1) Summary of electrical testing for the Contract.
 - (2) Description of the equipment and ground loops tested.
 - (3) Description of the test and test procedures.
 - (4) Test results.
 - (5) Conclusions and recommendations.
 - (6) Completed test forms, including witness's signatures.
 - (7) List of test equipment and calibration documents.
 - (8) Date and time of the testing.
 - (9) Include the following data tabulated for each piece of equipment:
 - (a) Circuit number.
 - (b) Equipment or motor name and tag number, where applicable.
 - (c) Nameplate full-load-ampere rating.
 - (d) Motor service factor.
 - (e) Motor ambient temperature rating.
 - (f) Overload relay rating.
 - (g) Measured full load current.
 - (h) Measured discharge pressure (where applicable).
 - (i) Measured flow rate (where applicable).
 - (j) Infrared testing.
- d. Acceptance Criteria:



- 1) All grounding shall be acceptable less than 5 ohms.
- 2) Equipment operating within IEEE 142 industry and manufacturer's published tolerances and performing safely will be acceptable.

B. Non-Conforming Work

1. Equipment for which acceptable data has not been submitted, or has been submitted but rejected, is deemed to be unacceptable and not meeting the requirements of this Contract.

C. Manufacturer Services:

1. Where required to maintain the validity of the manufacturers' warranties, employ the manufacturer's and Supplier's starting personnel to perform testing and/or perform equipment startup.
 - a. Confirm with manufacturer that the electrical testing specified under this Contract will not void any warranties.

3.03 SYSTEM STARTUP

- A. Install equipment that has acceptable test data.
- B. Prior to starting equipment or systems, obtain and review the manufacturer's installation, operation, and starting instructions.
 1. Submit the manufacturer's installation, operation, and starting instructions for the equipment and systems to be tested to the Program/Project Manager for information.
- C. Verify the correctness of the wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16081

COMMUNICATIONS TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for testing communications backbone, riser, and horizontal cabling, and for communications field verification services required to perform the specified testing and inspections.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 16712 – Communications Backbone Cabling.
 - 3. Section 16713 – Communications Horizontal Cabling.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ACR: Attenuation to Crosstalk Ratio.
 - 2. AWG: American Wire Gauge.
 - 3. ELFEXT: Equal Level Far End Crosstalk.
 - 4. FDDI: Fiber Distributed Data Interface.
 - 5. FEXT: Far End Crosstalk.
 - 6. NEXT: Near End Crosstalk.
 - 7. OTDR: Optical Time-Domain Reflectometer.
 - 8. PSELFEXT: Power Sum Equal Level Far End Crosstalk.
 - 9. PVC: Polyvinyl Chloride.
 - 10. RCDD: Registered Communications Distribution Designer.
 - 11. TSB: Technical Systems Bulletin.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Connection: The joint made by mating 2 fibers terminated with remateable duplex SC connectors or ST connectors.
 - 3. Multimode Optical Fiber: An optical fiber that carries only many paths of light.
 - 4. Singlemode Optical Fiber: An optical fiber that carries only one path of light.
- C. Reference Standards:
 - 1. American National Standards Institute (ANSI):



- a. ANSI X3T9.5 – FDDI (Fiber Distributed Data Interface) Standard containing physical specifications.
2. Building Industry Consulting Services International (BICSI):
 - a. BICSI TDMM - Telecommunications Distribution Methods Manual.
 - b. BICSI OSPDRM – Outside Plant Design Manual.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. InterNational Committee for Information Technology Standards (INCITS):
 - a. ANSI/INCITS 231 – Information Systems – Fibre Distributed Data Interface (FDDI) – Physical Layer Protocol (PHY-2).
5. International Standards Organization/International Electromechanical Commission (ISO/IEC):
 - a. ISO 9001 – Quality Management Systems – Requirements.
 - b. ISO/IEC 11801 –International Standard for Information Technology – Generic Cabling for Customer Premises.
6. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
7. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - b. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA-568-B.3 – Optical Fiber Cabling Components Standard.
8. National Institute of Standards and Testing (NIST):
 - a. NIST Policy on Traceability.
 - b. NIST Standard Reference Material (SRM).
9. Telecommunications Industry Association (TIA):
 - a. ANSI/TIA-455-78-B - FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
 - b. TIA-569-B – Commercial Building Standard for Telecommunications Pathways.
 - c. ANSI/TIA-606-A – Administrative Standard for Commercial Telecommunications Infrastructure.
 - d. TSB-140 – Additional Guidelines for Field Test Length, Loss and Polarity of Optical Fibers.
10. Underwriters Laboratories, Inc. (UL):
 - a. UL 2196 – Tests for Fire Resistive Cables.
 - b. UL-Field Test Instruments Verified to TIA/EIA 568-B.2 and 568-B.2.1.
 - c. UL Qualification Tests and Follow-Up Service Requirements.
 - d. UL Product Directories.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Cooperate with the Program/Project Manager, or its designee, to facilitate the oversight of the testing services.
 - a. Notify the Program/Project Manager at least 2 weeks prior to the expected time of operations requiring inspection and testing services.
 - 1) When tests or inspections cannot be performed after such notice, notify the Program/Project Manager.
 - b. Oversight by the Owner in no way relieves the Contractor's obligations to perform the Work of the Contract.
2. Cooperate with laboratory personnel, and provide access to the Work.
3. Provide incidental labor and facilities to provide access to work to be tested, to facilitate tests and inspections, and for storage of test equipment.

B. Scheduling:

1. Provide communications field verification services in a timely manner for acceptance testing of the installation.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Certificates:
 - 1) Copies of the termination and test equipment calibration documents, and certification that the equipment calibration meets NIST standards.
 - b. Delegated Design Submittals:
 - 1) Communications Systems Testing Plan.
 - c. Qualification Statements:
 - 1) Qualifications of the Communication System Field Verification Team.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Certified copies of the field verification reports.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:



1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Code Compliance Testing:
 - a. Unless otherwise provided in the Contract Documents, responsibility for arranging for the inspections and tests required by codes or ordinances and which are made by a legally constituted authority, or by an Authority Having Jurisdiction responsible for plan approval for the Site, is the Contractor's.
 3. Communications Systems Testing Plan:
 - a. Develop a Communications Systems Testing Plan, and submit it to the Program/Project Manager for approval.
 - 1) Include a list of the termination and test equipment to be used to perform work.
- B. Qualifications:
1. Communication System Field Verification Team's Qualifications:
 - a. Employ a Communication System Field Verification Team certified by the communications equipment manufacturers as having completed the necessary training to complete the field verification activities specified herein.
 - 1) The Communication Testing Agency must employ a BICSI Registered Communications Distribution Designer (RCDD) who will be responsible for the onsite supervision of the Communication System Field Verification Team.
 - 2) The communications equipment field verification team must demonstrate their knowledge and compliance with all applicable BICSI, TIA/EIA, UL, and NFPA standards and codes.
 - b. Submit the qualifications of the Communication System Field Verification Team, including resumes that include documentation of completed training courses.
- C. Certifications:
1. Underwriters Laboratories, Inc. (UL) Listing:
 - a. Provide both non-shielded plenum and non-shielded nonplenum copper cable that is UL[®] listed for fire safety.
 2. ISO 9001 Certification:
 - a. Provide both non-shielded plenum and non-shielded nonplenum copper cable that is ISO 9001 certified.

PART 2 PRODUCTS

2.01 COMMUNICATIONS SYSTEMS

- A. Performance:
1. Attenuation:



- a. The general attenuation equation for any link segment is as follows:
 - 1) Link Attenuation equals Cable Attenuation plus Connection Attenuation plus Fusion Splice Attenuation.
 - 2) 62.5 μ m Multimode Attenuation Coefficients:
 - a) Cable Attenuation: Cable Length (km) times either 3.75dB/km at 850nm or 1.5dB/km at 1300nm.
 - b) Connection Attenuation (ST connectors): 0.75dB for each connector pair.
 - c) Fusion Splice Attenuation: Splices times 0.30dB.
 - 3) 8 μ m Single Mode Attenuation Coefficients:
 - a) Cable Attenuation: Cable Length (km) times either 1.0dB/km at 1310nm or 1.0dB/km at 1550nm.
 - b) Connection Attenuation (SC connectors): 0.75dB for each connector pair.
 - c) Fusion Splice Attenuation: Splices times 0.30dB.
 - b. If lower maximum attenuation values are specified by the chosen manufacturer, then take responsibility for meeting those maximum attenuation values specified by the manufacturer.
- B. Design Criteria:
- 1. Comply with the requirements specified in the PSHIA Premises Distribution System Standards, and the following:
 - a. ANSI/INCITS 231 (ANSI X3T9.5).
 - b. ANSI/TIA-606-A.
 - c. BICSI OSPDRM.
 - d. BICSI TDMM.
 - e. ISO/IEC 11801.
 - f. TIA-569-B.
 - g. TSB-140.
 - 2. Conflicts:
 - a. If conflicts between referenced requirements arise, comply with the one establishing the more stringent requirements.
 - b. If conflicts between referenced requirements and the Contract Documents arise, comply with the one establishing the more stringent requirements.
- C. Materials:
- 1. Telecommunications Building Wiring:
 - a. Communications Backbone Cabling:
 - 1) Provide communications backbone cabling complying with the requirements specified in Section 16712, Communications Backbone Cabling.
 - b. Communications Horizontal Cabling:
 - 1) Provide communications horizontal cabling complying with the requirements specified in Section 16713, Communications Horizontal Cabling.



PART 3 EXECUTION

3.01 REPAIR/RESTORATION

- A. Bring Category 6 pairs not meeting the requirements of the standards into compliance at no increase in Contract Price.
- B. Bring optical fiber cable links not meeting the requirements of the standards into compliance at no increase in Contract Price.

3.02 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:
 - a. Perform the testing and verification specified herein.
 - 1) Furnish termination and test equipment calibrated in accordance with the traceability requirements of the National Institute of Standards and Testing (NIST).
 - 2) Submit a copy of the termination and test equipment calibration documents, and certification that the equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
 - b. Have all of the communications testing performed witnessed by the Program/Project Manager.
 - c. Inspections and testing performed exclusively for the convenience of the Contractor are the sole responsibility of the Contractor.
 - 2. Field Verification Reports:
 - a. After each inspection and test, promptly submit a certified copy of the field verification report to the Program/Project Manager within one week of completion of each test.
 - 1) Include the following in each report:
 - a) Date Issued.
 - b) Project and Contract title and number.
 - c) Contract phase of testing.
 - d) Field verification tester's name, address, and telephone number.
 - e) Name of the inspector, and job number.
 - f) Date and time of the sampling or inspection.
 - g) Record of the temperature and weather conditions.
 - h) Date of the test.
 - i) Identification of applicable Specification Section.
 - j) Location of the test in the Contract.
 - k) Cable identification, where applicable.
 - l) Type of inspection or test.
 - m) Results of the tests, and compliance with Contract Documents.



- n) Interpretation of the test results.
3. Category 6 Cable Test:
- a. Test Procedure:
- 1) Test Category 6 cable runs as outlined in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 for full conformance to the requirements specified for Category 6 cable in these standards and in the Contract Documents.
 - a) At a minimum, furnish a UL-Certified Level III test set complying with the requirements specified to perform the testing.
 - 2) Indicate the following information in the field verification report:
 - a) Length.
 - b) Wire map.
 - c) Characteristic impedance.
 - d) Attenuation.
 - e) Propagation delay.
 - f) Delay skew.
 - g) Return loss.
 - h) Near-End Crosstalk (NEXT).
 - i) Far-End Crosstalk (FEXT).
 - j) Equal-Level Far-End Crosstalk (ELFEXT).
 - k) Power Sum Equal-Level Far-End Crosstalk (PSELFEXT).
 - l) Attenuation to Crosstalk Ratio (ACR).
 - 3) Category 6 Cable Electrical Characteristics:
 - a) Verify that the Category 6 cables provided have the electrical characteristics listed in Table 16081-8.

Table 16081-8 - Category 6 Cable Electrical Characteristics	
Characteristic	Acceptable Value(s)
Mutual capacitance	47.8 nF/m
Characteristic impedance	($\pm 3\%$) of 100 Ohms 1-550 MHz
Maximum DC resistance	9.83 Ohms/100m)
Positive attenuation to crosstalk ratio (ACR)	Out to 395 MHz-km

- 4) Category 6 Cables Frequency Response:
 - a) Verify that the Category 6 cables provided meet or exceed the electrical characteristics indicated in Table 16081-9.

**Table 16081-9 - Category 6 Cable Electrical Characteristics**

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT	Return Loss
0.772	1.6	76.0	74.0	70.0	67.0	‡
1	1.8	74.3	72.3	67.8	64.8	20
4	3.6	65.3	63.3	55.7	52.7	23
8	5.1	60.8	58.8	49.7	46.7	24.5
10	5.8	59.3	57.3	47.8	44.8	25
16	7.3	56.3	54.3	43.7	40.7	25
20	8.2	54.8	52.8	41.7	38.7	25
25	9.2	53.3	51.3	39.8	36.8	24
31.25	10.4	51.9	49.9	37.9	34.9	24
62.5	15.0	47.4	45.4	31.8	28.8	22
100	19.3	44.3	42.3	27.8	24.8	20
200	28.3	39.8	37.8	21.7	18.7	18
250	32.1	38.3	36.3	19.8	16.8	17
300	35.6	37.2	35.2	18.2	15.2	17
350	38.9	36.2	34.2	16.9	13.9	16
400	42.0	35.3	33.3	15.7	12.7	16
450	45.0	34.5	32.5	14.7	11.7	16
500	47.9	33.8	31.8	13.8	10.8	15
550	50.6	33.2	31.2	12.9	9.9	15

- 5) Submit complete end to end test results to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) To be acceptable, both ends of the Category 6 cable runs must pass ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 acceptance requirements.
4. Optical Time-Domain Reflectometer (OTDR) Test:
 - a. Test Procedure:



- 1) Prior to installation of the optical fiber cable, test the cable while it is still on the reel with an optical time-domain reflectometer (OTDR).
- 2) In the completed end to end system, test all fibers by performing a bidirectional end to end OTDR trace in accordance with the requirements specified in ANSI/TIA-455-78-B.
 - a) Only use the optical time-domain reflectometer (OTDR) to determine the length of the cable and the attenuation of that cable.
 - b) Use a power meter to determine the overall link attenuation, including the connectors.
 - c) Measure the system loss for multimode fibers at 850 and 1300 nanometers, and for single mode fibers at 1310 and 1550 nanometers.
- 3) Calculate the loss numbers for the installed link by taking the sum of the bidirectional measurements and dividing that sum by 2.
 - a) Calculate the acquired loss statement only for the cable, and do not include the connectors as part of the calculated loss.
- 4) Submit documentation of the test to the point of contact to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Fiber optic cables having a loss equal to or less than the maximum allowable loss, which equals the allowable cable loss per kilometer times the length of the fiber in the link measured in kilometers, are acceptable.
5. Light Meter and Source Test:
 - a. Test Procedure:
 - 1) Test optical fiber cable with power meters.
 - 2) Unless the manufacture requires bi-directional testing to comply with warranty requirements, test the multimode inter-building and composite link segments in one direction at both 850-nm and 1300-nm wavelengths.
 - 3) Unless the manufacture requires bi-directional testing to comply with warranty requirements, test the singlemode inter-building and composite link segments in one direction at both 1310-nm and 1550-nm wavelengths.
 - b. Acceptance Criteria:
 - 1) Fiber links having a loss equal to or less than the maximum allowable loss, which equals the allowable cable loss per kilometer times the length of the fiber in the link measured in kilometers plus 0.75dB per connector pair plus 0.3dB per fusion splice, are acceptable.
6. Inspections:
 - a. At a minimum, the Program/Project Manager, or its designated representative, will perform random and unannounced onsite reviews during the installation of copper cable.



- a) Conformance test 100 to 400 pair non-shielded plenum copper cable to verify compliance with the electrical requirements specified in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 for Category 3 cables.
- b) Verify that the non-shielded plenum copper cable meets or exceeds the electrical specifications listed in Tables 16081-2, Table 16081-3, and Table 16081-4.

Table 16081-2 - Non-Shielded Plenum Copper Cable Electrical Characteristics	
Characteristic	Acceptable Value(s)
Maximum DC Resistance	28.6 Ω /1,000 feet (9.38 Ω /100m)
Maximum DC Resistance Unbalanced	5 percent
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 feet (328pF/m)
Mutual Capacitance @ 1kHz, maximum	16 nF/1000 feet (5.2nF/100 m)

Table 16081-3 - Non-Shielded Plenum Copper Cable Attenuation (dB/100m [328 feet])	
Frequency	Attenuation (Max.)
1.00 MHz	7 dB
4.00 MHz	15 dB
10.00 MHz	26 dB
16.00 MHz	35 dB

Table 16081-4- Non-Shielded Plenum Copper Cable Worst Pair Near-End Crosstalk (NEXT) (dB/100m [328 ft])	
Frequency	Pair-To-Pair NEXT
1.0 MHz	41 dB
4.0 MHz	32 dB
10.0 MHz	26 dB
16.0 MHz	23 dB

- 1) Non-Shielded Nonplenum Copper Cable:



- a) Conformance test 25 to 1800 pair non-shielded nonplenum copper cable to verify compliance with the electrical requirements specified in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 for Category 3 cables.
- b) Verify that the non-shielded nonplenum copper cable meets or exceeds the electrical specifications listed in Tables 16081-5, Table 16081-6, and Table 16081-7.

Table 16081-5 - Non-Shielded Nonplenum Copper Cable Resistance and Capacitance

Type of Resistance or Capacitance	Acceptable Value(s)
Maximum DC Resistance	28.6 Ω /1,000 feet (9.4 Ω /100m)
Maximum DC Resistance Unbalanced	5 percent
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 feet (328 pF/m)
Mutual Capacitance at 1kHz, maximum	18 nF/1000 feet (5.9 nF/100 m)

Table 16081-6- Non-Shielded Nonplenum Copper Cable Attenuation (dB/100 m [328 ft.])

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

Table 16081-7- Non-Shielded Nonplenum Copper Cable Worst Pair Near-End Crosstalk [NEXT] (dB/100m [328 ft])

Frequency	Pair-To-Pair NEXT
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB



- 1) Submit documentation of the test to the Program/Project Manager for information.

3.03 SYSTEM STARTUP

- A. Provide system startup as specified in Section 16702, Basic Communications Materials and Methods.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16120

CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for building wires and cables rated 600 V and less.
 - 2. Requirements for connectors, splices, and terminations rated 600 V and less.
 - 3. Requirements for sleeves and sleeve seals for cables.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 02316 - Trenching and Backfilling.
 - 3. Section 07850 – Through Penetration Firestopping Systems.
 - 4. Section 07920 – Joint Sealants.
 - 5. Section 16061 - Electrical Grounding and Bonding.
 - 6. Section 16071 –Seismic Controls.
 - 7. Section 16075 – Electrical Identification.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NRTL: Nationally recognized testing laboratory.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
- C. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 4. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 5. National Electrical Manufacturers Association (NEMA)



- a. ANSI/NEMA WC 70 - Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- 6. National Fire Protection Association (NFPA).
 - a. NFPA 70 – National Electrical Code (NEC).
- 7. Underwriters Laboratories, Inc. (UL).
 - a. UL 486A- UL 486B – Wire Connectors.
- 8. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Copper conductors.
 - 2) Multiconductor cables.
 - 3) Connectors and splices.
 - 4) Steel pipe sleeves.
 - 5) Cast-iron pipe sleeves.
 - 6) Sleeves for rectangular openings.
 - 7) Sleeve seals.
 - b. Certificates:
 - 1) NETA Certificates for the conductors and cables.
 - c. Qualification Statements:
 - 1) Electrical Testing Laboratory's qualifications.
 - 2) Electrical Testing Laboratory Field Supervisor's qualifications

B. Informational Submittals:

- 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Conductors and Cables Test Report.
 - 2) Certified copy of the Record of Infrared Scanning.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

- 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- 2. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
- B. Qualifications:
 - 1. Electrical Testing Laboratory (ETL) Qualifications:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, employ a member company of the InterNational Electrical Testing Association (NETA) or an independent nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 having the experience and capability to conduct the testing required, and acceptable to the Authorities Having Jurisdiction.
 - b. Submit the qualifications of the Electrical Testing Laboratory (ETL) to the Program/Project Manager for approval.
 - 2. Electrical Testing Laboratory's Field Supervisor's Qualifications:
 - a. To supervise the onsite testing specified, designate a person to be the Electrical Testing Laboratory's Field Supervisor who is currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET).
 - b. Submit the qualifications of the Electrical Testing Laboratory's Field Supervisor to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Electrical Listing and Labeling:
 - a. Provide conductor products that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) acceptable to the Authorities Having Jurisdiction (AHJ), for the location the product is installed in and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended location and/or application.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.



- a) Such evidence may consist of either a printed mark on the data or a separate listing card.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

A. Manufacturers:

1. Substitution Limitations:

- a. The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not meant to preclude other manufacturers that may be qualified to provide electrical conductor and cable products.
- b. Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
- c. Provide the standard products of a manufacturer regularly engaged in the manufacture of electrical conductor and cable products.

2. Product Options:

a. Product Data:

- 1) Submit manufacturers Product Data for the conductor and cable products proposed for the Work of this Section to the Program/Project Manager for approval.

B. Regulatory Requirements:

- 1. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work of this Section, including among others the following:
 - a. Phoenix Building Construction Code and Amendments.

C. Design Criteria:

- 1. Provide conductors and cables complying with the requirements specified in NFPA 70, and specified for the individual products.
- 2. Conductor Material Requirements by Application:
 - a. Feeders:
 - 1) For No. 10 AWG and smaller sizes, provide solid copper conductors.
 - 2) For No. 8 AWG and larger sizes, provide stranded copper conductors.
 - b. Branch Circuits:
 - 1) For No. 10 AWG and smaller sizes, provide solid copper conductors.
 - 2) For No. 8 AWG and larger sizes, provide stranded copper conductors.
- 3. Conductor Insulation and Multiconductor Requirements:
 - a. Service Entrances:
 - 1) Provide Type XHHW single conductors in raceway.



- b. Concealed Feeders:
 - 1) For feeders concealed in ceilings, walls, partitions, or crawlspaces, provide Type XHHW single conductors in raceway.
 - 2) For feeders concealed in concrete, below slabs-on-grade, and underground, provide Type XHHW single conductors in raceway.
- c. Concealed Branch Circuits:
 - 1) For branch circuits concealed in ceilings, walls, or partitions, provide Type THHN-THWN single conductors in raceway.
 - 2) For branch circuits concealed in concrete, below slabs-on-grade, and underground, provide Type XHHW single conductors in raceway.
- d. Cord Drops and Portable Appliance Connections:
 - 1) Provide Type SO hard service cord with a stainless-steel, wire-mesh, strain relief device at terminations to suit the application.
- e. Class 1 Control Circuits:
 - 1) Provide Type THHN-THWN conductors in raceway.
- 4. Coordinate the selection and application of sleeves for cables with the selection and application of the firestopping materials specified in Section 07850, Through-Penetration Firestopping Systems.

D. Materials:

- 1. Conductors and Cables:
 - a. Copper Conductors:
 - 1) Provide copper conductors complying with the requirements specified in NEMA WC 70.
 - 2) Conductor Insulation:
 - a) Provide insulation for copper conductors complying with the requirements for Types THW, THHN-THWN, XHHW, and SO specified in NEMA WC 70.
 - b. Multiconductor Cables:
 - 1) Provide multiconductor cable complying with the requirements for Type SO with a ground wire specified in NEMA WC 70.
 - c. Manufacturers:
 - 1) Alcan Products Corporation; Alcan Cable Division, <http://www.stabiloy.com/cablepublic/en-US>.
 - 2) Leviton Company, www.leviton.com.
 - 3) General Cable Corporation, www.generalcable.com.
 - 4) Southwire Company, www.southwire.com.
 - 5) Approved equal.
- 2. Connectors and Splices:
 - a. Provide factory-fabricated connectors and splices of the size, ampacity rating, material, type, and class for the application and service indicated in the Contract Documents.
 - b. Manufacturers:
 - 1) AFC Cable Systems, Inc., www.afcweb.com
 - 2) Hubbell Power Systems, Inc., www.hubbellpowersystems.com



- 3) EGS/O-Z/Gedney, www.o-zgedney.com.
 - 4) 3M; Electrical Products Division. www.3m.com
 - 5) Tyco Electronics Corp., <http://www.te.com/usa-en/home.html>.
 - 6) Approved equal.
3. Sleeves for Cables:
- a. Steel Pipe Sleeves:
 - 1) Provide Schedule 40, galvanized steel pipe sleeves with plain ends complying with the requirements specified for Type E, Grade B steel in ASTM A 53/A 53M.
 - b. Cast-Iron Pipe Sleeves:
 - 1) Unless otherwise indicated in the Contract Documents, provide cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and an integral waterstop.
 - c. Sleeves for Rectangular Openings:
 - 1) Provide galvanized sheet steel, a minimum 0.052 (1.3mm) thick or as otherwise indicated, and of a length to suit the application.
4. Sleeve Seals:
- a. To fill the annular space between sleeves and cables, provide a modular sealing device designed for field assembly.
 - b. Sealing Elements:
 - 1) Provide EPDM interlocking links shaped to fit the surface of the cable or conduit.
 - 2) Provide the type and number of sealing elements required for the material and size of the raceway or cable.
 - c. Pressure Plates:
 - 1) Provide 2 carbon steel pressure plates for each sealing element.
 - d. Connecting Bolts and Nuts:
 - 1) Provide carbon steel bolts and nuts having a corrosion-resistant coating, and of the length required to secure the pressure plates to the sealing elements.
 - 2) Provide one set of bolts and nuts for each sealing element.
 - e. Manufacturers:
 - 1) Advance Products & Systems, Inc., www.apsonline.com.
 - 2) Calpico, Inc., www.calpicoinc.com.
 - 3) Metraflex Co., www.metraflex.com.
 - 4) GPT, www.pipeline-seal.com.
 - 5) Approved equal.

2.02 ACCESSORIES

- A. Firestopping Materials:
1. Provide firestopping materials complying with the requirements specified in Section 07850, Through-Penetration Firestopping Systems.
- B. Joint Sealant:



1. Provide joint sealant complying with the requirements specified in Section 07850, Joint Sealants.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Inspect all conduits, junction boxes, electrical vaults, and handholes to verify that they are clean, that they do not have burrs, that conduits are properly aligned, and that they are complete.
 - a. Ensure that on all conduits without threaded hubs, two locknuts are installed.
 - b. Ensure that in all conduits with wires larger than No. 10, bushings are installed.
 - c. Ensure that grounding bushings and fittings are installed at all places specified in Section 16061, Electrical Grounding and Bonding.
 - d. Verify that proper sized boxes are installed.
2. Verify that boxes and conduit fittings conform to the bending requirements specified in Article 314 of NFPA 70 (NEC).

B. Evaluation and Assessment:

1. Do not begin installing wiring until other work which might cause damage to the wires, cables, or conduits has been completed.
 - a. Correct deficiencies in conduits, junction boxes, electrical vaults, and handholes that have been discovered by inspection.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the conductors and cables.
2. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.

B. Surface Preparation:

1. Perform excavation, trenching, and backfilling, if required, as specified in Section 02316, Trenching and Backfilling.
2. Prepare conduits to receive wire and cable.
 - a. Swab the conduits with a nylon brush and steel mandrel.
 - b. Pre-lubricate the conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.
3. Verify that pulling calculations have been made and are available for long conduit runs and pulls as indicated in this Section.



4. Verify that a means of controlling the pulling tension on the wire or cable is installed on the mechanical assist devices furnished for pulling cable.

3.03 INSTALLATION

A. Conductors and Cables:

1. Unless otherwise indicated in the Contract Documents, conceal cables in finished walls, ceilings, and floors.
2. Pulling Cable:
 - a. Furnish a means for pulling cables, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage the cables or raceway.
 - b. Provide a manufacturer-approved pulling compound or lubricant where necessary.
 - 1) The compound provided must not deteriorate the conductor or insulation.
 - c. When pulling cable, do not exceed the manufacturer's recommended maximum pulling tensions and sidewall pressure values.
3. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
4. Identify and color-code conductors and cables in accordance with the requirements specified in Section 16075, Electrical Identification.
5. Support cables in accordance with the requirements specified in Section 16070, Hangers and Supports, and Section 16071 –Seismic Controls.

B. Connections:

1. Make splices and taps that are compatible with the conductor material, and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 - a. For aluminum conductors, provide oxide inhibitor in each splice and tap conductor.
2. Tighten electrical connectors and terminals according to the manufacturer's published torque-tightening values.
 - a. If the manufacturer's torque values are not indicated, tighten the electrical connectors and terminals in accordance with the requirements specified in UL 486A and UL 486B.
3. Wiring at Outlets:
 - a. Install conductors at each outlet having at least 6 inches of slack.

C. Special Techniques:

1. Sleeves for Electrical Penetrations:
 - a. Set sleeves for electrical penetrations in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
 - 1) Install the sleeves during the erection of concrete slabs and walls.



- b. Provide pipe sleeves unless the penetration arrangement requires a rectangular sleeved opening.
 - 1) For rectangle sleeves having perimeters less than 50 inches and having no side greater than 16 inches, provide 0.052-inch thick sleeves.
 - 2) For rectangle sleeves having perimeters equal to or greater than 50 inches and having one or more sides greater than 16 inches, provide 0.138 -inch thick sleeves.
 - 3) Size pipe sleeves to provide 1/4-inch annular clear space between the sleeve and the cable unless sleeve seal is to be installed or seismic criteria require different clearance.
- c. For sleeves mounted in walls, cut the sleeves to length flush with both wall surfaces.
- d. For sleeves mounted in floors, extend the sleeves 2 inches above finished floor level.
- e. Seal the space outside sleeves with grout for penetrations of concrete and masonry, and with approved joint compound for gypsum board assemblies.
- f. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - 1) Seal the annular space between the sleeve and cable using joint sealant appropriate for size, depth, and location of the joint.
- g. Fire-Rated-Assembly Penetrations:
 - 1) At cable penetrations of fire-rated walls, partitions, ceilings, and floors, maintain the fire rating indicated in the Contract Documents.
 - 2) Install sleeves, and seal the penetration with firestopping materials as specified in Section 07850, Through-Penetration Firestopping Systems, to restore original fire-resistance rating of the assembly.
- h. Aboveground Exterior-Wall Penetrations:
 - 1) For electrical penetrations through aboveground exterior walls, provide sleeves and mechanical sleeve seals to seal the penetration.
 - 2) Size the sleeves to allow for a 1-inch annular clear space between the pipe and sleeve for installing the mechanical sleeve seals.
- i. Underground Exterior-Wall Penetrations:
 - 1) For electrical penetrations through underground exterior walls, provide cast-iron "wall pipes".
 - 2) Size the wall pipes to allow for a 1-inch annular clear space between the cable and wall pipe for installing mechanical sleeve seals.
- 2. Sleeve Seals for Sleeves:
 - a. To seal underground exterior-wall penetrations, provide sleeve seals.
 - b. Provide the type and number of sealing elements recommended by the manufacturer for the cable material and size.
 - c. Position the cable in the center of the sleeve.



- d. Assemble the mechanical sleeve seals, and install it in the annular space between the cable and sleeve.
 - e. Tighten the seals bolts against pressure plates to cause the sealing elements to expand and make a watertight seal.
- D. Interface with Other Work:
 - 1. Concrete Slabs and Walls:
 - a. Unless core-drilled holes or formed openings have been provided in concrete slabs and walls for electrical penetrations, provide sleeves for the penetrations.
 - 2. Fire-Rated Assemblies:
 - a. For electrical penetrations of fire-rated floor and wall assemblies, unless openings compatible with the firestopping system used are fabricated during construction of the floor or wall, provide sleeves.
 - 3. Roof-Penetrations:
 - a. For penetrations by individual electrical cables through roofs, provide flexible boot-type flashing units applied in coordination with the roofing Work to seal the penetrations.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test specified in ANSI/NETA ATS for conductors and cables.
 - a. Submit NETA Certificates for the conductors and cables that certify compliance with required NETA test results to the Program/Project Manager for information.
 - 2. Site Tests:
 - a. After installing conductors and cables, and before electrical circuitry has been energized, test the service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with the requirements specified:
 - 1) Panelboards.
 - 2) Switchboards.
 - 3) Motor control centers.
 - b. Perform the electrical testing specified for conductors and cables in Section 16080, Electrical Testing.
 - c. Conductors and Cables Test Report:
 - 1) Prepare a written Conductors and Cables Test Report to record the following:
 - a) Test procedures used.
 - b) Test results that comply with the requirements specified.
 - c) Test results that do not comply with the requirements specified, and corrective action taken to achieve compliance with the requirements.



- 2) Submit the Conductors and Cables Test Report to the Program/Project Manager for information.
3. Inspections:
 - a. Infrared Scanning:
 - 1) Instrument:
 - a) Furnish an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - (1) Submit a copy of the calibration record for the device to the Program/Project Manager for information.
 - 2) Initial Scan:
 - a) After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in 3 AWG and larger cables and conductors.
 - b) Remove the box and equipment covers so splices are accessible to the portable scanner.
 - 3) Follow-up Infrared Scanning:
 - a) 11 months after the date of Substantial Completion, perform a follow-up infrared scan of each splice.
 - 4) Record of Infrared Scanning:
 - a) Prepare a certified report that identifies splices checked and that describes scanning results.
 - b) Record deficiencies detected, remedial action taken, and observations after remedial action in the report.
 - 5) Submit a certified copy of the Record of Infrared Scanning to the Program/Project Manager for information.

B. Non-Conforming Work

1. Remove and replace malfunctioning units, and have the replacements retested as specified herein.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16121

MEDIUM-VOLTAGE WIRE, CABLE, AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 02316 - Trenching and Backfilling.
 - 4. Section 07850 - Through-Penetration Firestopping Systems.
 - 5. Section 16050 - Basic Electrical Materials and Methods.
 - 6. Section 16061 - Electrical Grounding and Bonding.
 - 7. Section 16075 - Electrical Identification.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EPDM: Ethylene propylene diene M-class rubber.
 - 2. PVC: Polyvinyl-chloride.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Intumescent: A substance that swells as a result of heat exposure, thus increasing its volume and decreasing its density.
 - 3. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
- C. Reference Standards:
 - 1. The Association of Edison Illuminating Companies (AEIC):
 - a. AEIC CS8 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV.
 - 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.



3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. Insulated Cable Engineers Association, Inc. (ICEA):
 - a. ICEA S-97-682 – Standard for Utility Shielded Power Cables Rated 5 Through 46 kV.
 - b. ICEA T-31-610 – Test Method for Conducting Longitudinal Water Penetration Resistance Tests on Blocked Conductors.
5. Institute of Electrical and Electronic Engineers (IEEE):
 - a. IEEE C2 – National Electric Safety Code.
 - b. IEEE 48 – IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kV Through 765 kV.
 - c. IEEE 386 – IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.
 - d. IEEE 404 – IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500 000 V.
 - e. IEEE 576 – IEEE Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
8. National Electrical Manufacturing Association (NEMA):
 - a. ANSI/NEMA WC 74/ICEA S-93-639 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
9. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
10. Underwriters Laboratories, Inc. (UL):
 - a. UL 1072 – Standard for Safety Medium-Voltage Power Cables.
11. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved



Agency, and the City, prior to incorporating items requiring testing by them into the Work.

B. Sequencing:

1. Install and clean raceway, conduit, and ductbank for medium-voltage cables, and excavate trenches for direct-burial medium-voltage cables, prior to installing the medium-voltage cables.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Medium-voltage cables.
 - 2) Splice kits.
 - 3) Shielded-cable terminations.
 - 4) Terminations at distribution points.
 - 5) Load-break cable terminators.
 - 6) Dead-break cable terminators.
 - 7) Dead-front terminal junctions.
 - 8) Surge Arrestors.
 - 9) Test-point fault indicators.
 - b. Samples:
 - 1) Samples of each type of medium-voltage cable.
 - c. Certificates:
 - 1) Electrical Listing and Labeling.
 - 2) Manufacturer's Material Certificates for each type of cable and accessory.
 - d. Qualification Statements:
 - 1) Medium-voltage cable installer's qualifications.
 - 2) Testing Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Splicing kit manufacturer's recommended types, and detailed instructions for installing the splicing products.
 - b. Source Quality Control Submittals:
 - 1) Medium-Voltage Cable Test reports.
 - 2) Water-Penetration Resistance Test reports.
 - c. Site Quality Control Submittals:
 - 1) NETA Certificates for the medium-voltage conductors and cables.



C. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Tools:
 - 1) Tool set, including the shotgun hot stick with an energized terminal indicator, fault-indicator test tool, and carrying case

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Medium-Voltage Cable Installer's Qualifications:
 - a. Engage a cable splicer, trained and certified by the splice material manufacturer, to install, splice, and terminate the medium-voltage cable.
 - b. Submit the medium-voltage cable installer's qualifications to the Program/Project Manager for approval.
2. Testing Agency's Qualifications:
 - a. Employ a Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL), that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the



InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET).

- 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

2. Manufacturer's Material Certificates of Compliance:

- a. Submit material certificates, signed by the manufacturers, to the Program/Project Manager that certify each type of cable and accessory complies with the specified requirements, including compliance with the referenced standards and the type designations within the standards:

D. Site Samples:

1. Submit 16-inch long Samples of each type of medium-voltage cable to be provided under this Section to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:



1. Handle materials in accordance with the manufacturer's written instructions.
2. Store all products, whether on-site or off-site, indoors on blocking or pallets.
3. Follow the manufacturer's written instructions for storing the items.
4. Store electrical products under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

1.07 SITE CONDITIONS

A. Existing Conditions:

1. Interruption of Existing Electric Service:
 - a. Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electric service according to the requirements indicated:
 - 1) Notify the Program/Project Manager no fewer than 2 days in advance of the proposed interruption of electric service.
 - 2) Do not interrupt electric service without the Program/Project Manager's written permission.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain cables and accessories through one source from a single manufacturer.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC) and Other Codes:



- 1) Provide products and installation complying with requirements specified for medium-voltage wire, cable, and accessories in NFPA 70 and IEEE C2.

C. Performance:

1. Cables:

- a. Provide medium-voltage cables complying with the performance requirements specified in UL 1072, AEIC CS8, ANSI/NEMA WC 74/ICEA S-93-639, and ICEA S-97-682.

D. Design Criteria:

1. Cables:

- a. Provide medium-voltage cables complying with the design requirements specified in UL 1072, AEIC CS8, ANSI/NEMA WC 74/ICEA S-93-639, and ICEA S-97-682.

2. Shielded-Cable Terminations:

- a. Provide shielded-cable terminations complying with the requirements for the following classes as specified in IEEE 48:

1) Class 1 Terminations:

- a) Modular type, furnished as a kit, with a stress-relief tube; multiple, molded-silicone rubber, insulator modules; a shield ground strap; and a compression-type connector.
- b) Modular type, furnished as a kit, with a stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; a shield ground strap; and a compression-type connector.
- c) Heat-shrink type with heat-shrink inner stress control and outer non-tracking tubes; multiple, molded, non-tracking skirt modules; and a compression-type connector.

2) Class 1 Terminations, Indoors:

- a) Kit with a stress-relief tube, a non-tracking insulator tube, a shield ground strap, a compression-type connector, and an end seal.

3) Class 2 Terminations, Indoors:

- a) Kit with a stress-relief tube, a non-tracking insulator tube, a shield ground strap, and a compression-type connector.
 - (1) Include silicone-rubber tape, a cold-shrink-rubber sleeve, or a heat-shrink plastic-sleeve moisture seal for the end of the insulation whether or not it is supplied with the kits.

4) Class 3 Terminations:

- a) Kit with a stress cone and a compression-type connector.

3. Separable Connector Systems:

- a. Provide insulated separable connectors complying with the requirements specified in IEEE 386, and designed to accommodate the cable voltage and to seal against the intrusion of moisture.

4. Product Data:



- a. Submit manufacturers Product Data for each type of medium-voltage cable product proposed for the Work of this Section to the Program/Project Manager for approval.
 - 1) Include splices and terminations for the cables, and cable accessories.

E. Materials:

1. Medium-Voltage Cables:

- a. Provide medium-voltage cables complying with the following requirements:
 - 1) Cable Type:
 - a) Provide cables complying with the requirements for MV105 type cable as specified in UL 1072.
 - 2) Conductors:
 - a) Provide copper conductors.
 - 3) Conductor Stranding:
 - a) Provide cables having compressed round, concentric lay, Class B conductor stranding.
 - 4) Strand Filling:
 - a) Fill the conductor interstices of the medium-voltage cables with impermeable compound that complies with the following requirements:
 - (1) Voltage Rating: 15 kV.
 - (2) Insulation Thickness: 133 percent insulation level.
 - 5) Conductor Insulation:
 - a) Insulate the medium-voltage cable conductors with ethylene-propylene rubber complying with the following requirements:
 - (1) Voltage Rating: 15 kV.
 - (2) Insulation Thickness: 133 percent insulation level.
 - 6) Shielding:
 - a) Provide copper tape shielding on the medium-voltage cables, helically applied over a semiconducting insulation shield.
 - 7) Shielding and Jacket:
 - a) Provide corrugated copper drain wires embedded in an extruded, chlorinated, polyethylene jacket on the medium-voltage cables.
 - 8) Cable Jacket:
 - a) Provide a sunlight-resistant PVC cable jacket on the medium-voltage cables.
- b. Manufacturers:
 - 1) General Cable Technologies Corporation, www.generalcable.com/GeneralCable.
 - 2) The Okonite Company, www.okonite.com.
 - 3) Prismian Energy. Cables and Systems, www.prysmian.com.
 - 4) Southwire Company, www.southwire.com.



5) Approved Equal.

2.02 ACCESSORIES

A. Splice Kits:

1. Connectors and Splice Kits:

- a. Provide connectors and splice kits complying with the requirements specified in EEE 404; of the type recommended by the cable or splicing kit manufacturer for the application.

2. Splicing Products:

- a. Provide the following types of splicing products as recommended, in writing, by the splicing kit manufacturer for the specific sizes, ratings, and configurations of the cable conductors:
 - 1) Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 - 2) Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 - 3) Premolded, cold-shrink-rubber, in-line splicing kit.
 - 4) Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
- b. Include all components required for a complete splice.
- c. Submit the splicing kit manufacturer recommended types, and detailed instructions for installing the splicing products, to the Program/Project Manager for information.
- d. Manufacturers:
 - 1) Engineered Products Company (EPCO), www.engproducts.com.
 - 2) G&W Electric Company, www.gwelec.com.
 - 3) MP Husky, www.mphusky.com.
 - 4) Tyco Electronics, Raychem Products, www.raychemsupply.com/Raychem.
 - 5) RTE Industrial Components, www.rtecomponents.com.
 - 6) Adalet, a Scott Fetzer Company, www.adalet.com.
 - 7) Thomas & Betts Corporation, www.tnb.com.
 - 8) Thomas & Betts Corporation/Elastimold, www.tnb.com/ps/util.
 - 9) 3M; Electrical Products Division, <http://solutions.3m.com/wps>.
 - 10) Approved Equal.

B. Solid Terminations:

1. Shielded-Cable Terminations:

- a. Provide shielded-cable terminations having the insulation class equivalent to that of the cable being terminated.
 - 1) Include a shield ground strap for shielded cable terminations.
- b. Manufacturers:
 - 1) Engineered Products Company (EPCO), www.engproducts.com.



- 2) G&W Electric Company, www.gwelec.com.
- 3) MP Husky, www.mphusky.com.
- 4) Tyco Electronics, Raychem Products, www.raychemsupply.com/Raychem.
- 5) RTE Industrial Components, www.rtecomponents.com.
- 6) Adalet, a Scott Fetzer Company, www.adalet.com.
- 7) Thomas & Betts Corporation, www.tnb.com.
- 8) Thomas & Betts Corporation/Elastimold, www.tnb.com/ps/util.
- 9) 3M; Electrical Products Division, <http://solutions.3m.com/wps>.
- 10) Approved Equal.

C. Surge Arrestors

1. Surge Arrestors:
 - a. Provide surge arrestors that conform to IEEE Std 386-2006.
 - b. Manufacturers:
 - 1) Engineered Products Company (EPCO), www.engproducts.com.
 - 2) G&W Electric Company, www.gwelec.com.
 - 3) MP Husky, www.mphusky.com.
 - 4) Tyco Electronics, Raychem Products, www.raychemsupply.com/Raychem.
 - 5) RTE Industrial Components, www.rtecomponents.com.
 - 6) Adalet, a Scott Fetzer Company, www.adalet.com.
 - 7) Thomas & Betts Corporation, www.tnb.com.
 - 8) Thomas & Betts Corporation/Elastimold, www.tnb.com/ps/util.
 - 9) 3M; Electrical Products Division, <http://solutions.3m.com/wps>.
 - 10) Approved Equal.

D. Separable Insulated Connectors:

1. Provide modular disconnecting, single-pole, cable terminators with matching, stationary, plug-in, dead-front terminals.
2. Terminations at Distribution Points:
 - a. For distribution points, provide modular type terminations consisting of terminators installed on cables, and of modular, dead-front, terminal junctions for the interconnecting cables.
3. Load-Break Cable Terminators:
 - a. For load-break cable terminators, provide elbow-type units with a 200 Amp load make/break and a continuous-current rating; coordinated with the insulation diameter, conductor size, and material of the cable being terminated.
 - b. Include a test point on the terminator body that is capacitance coupled.
4. Dead-Break Cable Terminators:
 - a. For dead-break cable terminators, provide an elbow-type unit with a 600 Amp continuous-current rating designed for de-energized



- disconnecting and connecting, and coordinated with the insulation diameter, conductor size, and material of the cable being terminated.
- b. Include a test point on the terminator body that is capacitance coupled.
- 5. Dead-Front Terminal Junctions:
 - a. For dead-front terminal junctions, provide modular bracket-mounted groups of stationary terminals that mate and match with specified cable terminators.
 - b. Provide two-, three-, or four-terminal units as indicated in the Contract Documents, and having fully rated, insulated, watertight conductor connections between the terminals and a grounding lug.
 - c. Provide terminals complete with the manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 - d. Protective Cap:
 - 1) Provide an insulating, electrostatic-shielding, water-sealing protective cap with a drain wire.
 - e. Feed-Through Accessory Units:
 - 1) Provide portable, two-terminal, removable dead-front junctions arranged for mounting on an accessory stand of the stationary terminal junction.
 - f. Grounding Kit:
 - 1) Provide a grounding kit consisting of jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding the 3 phases of the feeders, and a carrying case.
 - g. Standoff Insulator:
 - 1) Provide portable, single removable dead-front terminals for mounting on an accessory stand of the stationary terminal junction.
 - a) Provide insulators suitable for fully insulated isolation of the energized cable-elbow terminators.
- 6. Test-Point Fault Indicators:
 - a. Provide test-point fault indicators having the applicable current-trip ratings, arranged for installation in the test points of the load-break separable connectors, and complete with self-resetting indicators capable of being installed with a shotgun hot stick and of being tested with test tool.
- 7. Tool Set:
 - a. Furnish a shotgun hot stick with an energized terminal indicator, a fault-indicator test tool, and a carrying case.
 - b. Submit the tool set to the Program/Project Manager at the completion of medium-voltage wire and cable.
- 8. Manufacturers:
 - a. Engineered Products Company (EPCO), www.engproducts.com.



- b. G&W Electric Company, www.gwelec.com.
 - c. MP Husky, www.mphusky.com.
 - d. Tyco Electronics, Raychem Products, www.raychemsupply.com/Raychem.
 - e. RTE Industrial Components, www.rtecomponents.com.
 - f. Adalet, a Scott Fetzer Company, www.adalet.com.
 - g. Thomas & Betts Corporation, www.tnb.com.
 - h. Thomas & Betts Corporation/Elastimold, www.tnb.com/ps/util.
 - i. 3M; Electrical Products Division, <http://solutions.3m.com/wps>.
 - j. Approved Equal.
- E. Arc-Proofing Materials:
- 1. Tape for the First Course on Metal Objects:
 - a. Provide corrosion-protective, moisture-resistant, polyvinyl-chloride (PVC) pipe-wrapping tape 10 mils thick.
 - 2. Arc-Proofing Tape:
 - a. Provide flexible, conformable, fireproof tape that is intumescent to 0.3 inch thick and compatible with the cable jacket.
 - 3. Glass-Cloth Tape:
 - a. Provide pressure-sensitive adhesive type, 1/2 inch wide.
- F. Fault Indicators:
- 1. Indicators:
 - a. Provide automatically reset fault indicators having an inrush restraint feature, and arranged to clamp to the cable sheath and provide a display after a fault has occurred in the cable.
 - 1) Provide an instrument that is not affected by heat, moisture, and corrosive conditions; and that is recommended by the manufacturer for the installation conditions.
 - 2. Resetting Tool:
 - a. Provide a resetting tool designed for use with the fault indicators, and a moisture-resistant storage and carrying case.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
- 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 - 2. Medium-Voltage Cable Test:
 - a. Test Procedure:
 - 1) Prior to shipping medium-voltage cables to the Site, test the cables in accordance with the procedures specified in ICEA S-97-682.
 - 2) Document the testing, and prepare and submit certified test reports to the Program/Project manager for information.



- b. Acceptance Criteria:
 - 1) Shielded power cables complying with the requirements specified in ICEA S-97-682 pass the Shielded Cable Test, and may be shipped to the Site.
 - 3. Water-Penetration Resistance Test:
 - a. Test Procedure:
 - 1) Test strand-filled or sealed conductors for water-penetration resistance in accordance with the procedures specified in ICEA T-31-610 using a test pressure of 5 psig.
 - 2) Document the testing, and prepare and submit certified test reports to the Program/Project manager for information.
 - b. Acceptance Criteria:
 - 1) Strand-filled cables complying with the requirements specified in ICEA T-31-610 pass the Water-Penetration Resistance Test, and may be shipped to the Site.
 - 4. Inspections:
 - a. Prior to shipping medium-voltage cables to the Site, inspect the cables in accordance with the procedures specified in ICEA S-97-682.
- B. Non-Conforming Work:
- 1. Do not ship non-conforming materials to the Site.
- C. Coordination of Other Tests and Inspections:
- 1. Notify the code-required Approved Agency responsible for performing special inspections when medium-voltage cables for this Contract are being manufactured and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
- 1. Inspect all conduits, junction boxes, electrical vaults, and handholes to verify that they are clean, that they do not have burrs, that conduits are properly aligned, and that they are complete.
 - a. Ensure that on conduits without threaded hubs, two locknuts are installed.
 - b. Ensure that in all conduits with wires larger than No. 10, bushings are installed.
 - c. Ensure that grounding bushings and fittings are installed at all places specified in Section 16061, Electrical Grounding and Bonding.
 - d. Verify that proper sized boxes are installed.



2. Verify that boxes and conduit fittings conform to the bending requirements specified in Article 314 of NFPA 70 (NEC).

B. Evaluation and Assessment:

1. Do not begin installing wiring until other work which might cause damage to the wires, cables, or conduits has been completed.
 - a. Correct deficiencies in conduits, junction boxes, electrical vaults, and handholes that have been discovered by inspection.

3.02 PREPARATION

A. Protection of In-Place Conditions:

1. Protect adjacent areas from damage resulting from installation of the medium-voltage cables.
2. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.

B. Surface Preparation:

1. Perform excavation, trenching, and backfilling, if required, as specified in Section 02316, Trenching and Backfilling.
 - a. For medium-voltage cables that will be direct-buried within a trench, prepare, level, and tamp a 3-inch bed of sand.
2. Prepare conduits to receive wire and cable.
 - a. Swab the conduits with a nylon brush and steel mandrel.
 - b. Pre-lubricate the conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.
3. Verify that pulling calculations have been made and are available for long conduit runs and pulls as indicated in this Section.
4. Verify that a means of controlling the pulling tension on the wire or cable is installed on the mechanical assist devices furnished for pulling cable.

3.03 INSTALLATION

A. Install medium-voltage cables in accordance with the requirements specified in IEEE 576.

1. At pull points and where indicated on the Contract Drawings, install medium-voltage cable splices using standard kits.
2. Install terminations at the ends of conductors, and seal multi-conductor cable ends using standard kits.
3. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train medium-voltage cables around the walls by the longest route from the entry to the exit, and support cables at intervals adequate to prevent sag.
4. Support medium-voltage cables in accordance with the requirements specified in Section 16050, Basic Electrical Materials and Methods.



5. Install exposed cables parallel and perpendicular to the surfaces of exposed structural members, and follow the surface contours wherever possible.
 6. Provide surge arrestors on all cable terminations that conform to IEEE Std 386-2006.
- B. Pulling Conductors:
1. Do not exceed the manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 2. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate the conductor or insulation.
 3. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage the cables and raceways.
 4. Do not use rope hitches for a pulling attachment to the cable.
- C. Separable Insulated-Connector Components:
1. Where indicated on the Contract Drawings, install separable insulated-connector components as follows:
 - a. Protective Caps:
 - 1) Install protective caps at each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - b. Portable Feed-Through Accessory:
 - 1) Install 3 portable feed-through accessories.
 - c. Standoff Insulator:
 - 1) Install 3 standoff insulators.
- D. Arc Proofing:
1. Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials.
 2. In addition to following the arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - a. Clean the cable sheath.
 - b. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 - c. Smooth surface contours with electrical insulation putty.
 - d. Apply arc-proofing tape in 1 half-lapped layer with the coated side toward the cable.
 - e. Band arc-proofing tape with 1 inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches apart on center.
- E. Grounding:
1. Ground the shields of shielded medium-voltage cable at terminations, splices, and separable insulated connectors.
 - a. Ground the metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- F. Fault Indicators:



1. Install fault indicators on each phase wherever indicated on the Contract Drawings.

G. Special Techniques:

1. Firestopping:
 - a. Seal around medium-voltage cables passing through fire-rated elements in accordance with the requirements specified in Section 07850, Through-Penetration Firestopping Systems.
2. Identification:
 - a. Identify medium-voltage cables in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Install permanent markers at the ends of cable runs, changes in direction, and buried splices.
 - 2) Install "buried-cable" warning tape 12 inches above buried medium-voltage cables.

H. Interface with Other Work:

1. Separate buried medium-voltage cables crossing other cables or piping by a minimum of 4 inches of tamped earth.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when concrete is being placed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. InterNational Electrical Testing Association (NETA) Tests:
 - a. Provide NETA Tests on all existing medium voltage cables feeders A1, A2, A3, and P1 and on all new feeders A4 and A5.
 - b. Test Procedure:
 - 1) After installing medium-voltage cables but before the electrical circuitry has been energized, have the Testing Agency perform



- each electrical test specified in ANSI/NETA ATS for conductors and cables.
- 2) Submit NETA Certificates for the medium-voltage conductors and cables that certify compliance with required NETA test results to the Program/Project Manager for information.
 - c. Acceptance Criteria:
 - 1) Medium-voltage cables complying with the requirements specified in ANSI/NETA ATS pass the NETA Tests.
 3. Inspections:
 - a. Each visual and mechanical inspection specified in ANSI/NETA ATS for conductors and cables will be performed.
- B. Non-Conforming Work
1. Remove malfunctioning units, replace them with new and acceptable material, and retest the replacements materials as specified herein.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16123

CONTROL-VOLTAGE POWER CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for control voltage power cables, including the following:
 - a. Unshielded twisted pair (UTP) cabling.
 - b. Low-voltage control cabling.
 - c. Control-circuit conductors.
 - d. Identification products.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 02316 - Trenching and Backfilling.
 - 3. Section 07850 – Through Penetration Firestopping System.
 - 4. Section 16061 – Electrical Grounding and Bonding.
 - 5. Section 16075 – Electrical Identification.
 - 6. Section 16130 – Raceways and Boxes.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. DC: Direct current.
 - 2. EMI: Electromagnetic interference.
 - 3. HVAC: Heating ventilation and air conditioning.
 - 4. IDC: Insulation displacement connector.
 - 5. NRTL: Nationally recognized testing laboratory.
 - 6. PVC: Polyvinyl chloride.
 - 7. RCCD: Registered Communications Distribution Designer.
 - 8. UTP: Unshielded twisted pair.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
 - 3. Open Cabling: Passing telecommunications cabling through open space; for instance, between the studs of a wall cavity.
- C. Reference Standards:
 - 1. American National Standards Institute (ANSI):



- a. ANSI/J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
2. ASTM International (ASTM):
 - a. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. Building Industry Consulting Services International (BICSI):
 - a. BICSI ITSIMM - Information Transport Systems Installation Methods Manual.
 - b. BICSI TDMM - Telecommunications Distribution Methods Manual.
4. Insulated Cable Engineers Association, Inc. (ICEA):
 - a. ANSI/ICEA S-90-661 - ICEA Standard for Individually Unshielded Twisted Pair Indoor Cables (with or without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - b. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
6. National Electrical Contractors Association (NECA):
 - a. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.
7. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - b. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA-568-B.3 – Optical Fiber Cabling Components Standard.
 - d. ANSI/TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure.
8. Telecommunications Industry Association (TIA):
 - a. TIA-526-14-A – OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - b. TIA-569-B – Commercial Building Standard for Telecommunications Pathways.
9. Underwriters Laboratories, Inc. (UL):
 - a. UL 83 – Thermoplastic-Insulated Wires and Cables.
 - b. UL 444 - Communications Cables.
 - c. UL 969 – Standard for Marking and Labeling Systems.
 - d. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.03 SUBMITTALS

A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Support of open cabling.
 - 2) Conduit and boxes.
 - 3) Unshielded twisted pair (UTP) cable.
 - 4) Unshielded twisted pair (UTP) cable hardware.
 - 5) Low-voltage control paired cable.
 - 6) Low-voltage control plenum-rated, paired cable.
 - 7) Control-circuit conductors.
 - b. Shop Drawings:
 - 1) Cable tray layout.
 - c. Delegated Design Submittals:
 - 1) Cable tray load calculations.
 - d. Qualification Statements:
 - 1) Electrical Testing Laboratory (ETL) qualifications.
 - 2) Electrical Testing Laboratory's Field Supervisor's qualifications.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Control-Voltage Power Cables Test and Inspection Reports

1.04 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 2. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
- B. Qualifications:
 1. Electrical Testing Laboratory (ETL) Qualifications:



- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, employ a member company of the InterNational Electrical Testing Association or an independent nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 having the experience and capability to conduct the testing required, and acceptable to the Authorities Having Jurisdiction.
 - b. Submit the qualifications of the Electrical Testing Laboratory (ETL) to the Program/Project Manager for approval.
 - 2. Electrical Testing Laboratory's Field Supervisor's Qualifications:
 - a. To supervise the onsite testing specified, designate a person to be the Electrical Testing Laboratory's Field Supervisor who is currently certified by the Building Industry Consulting Services International (BICSI) as a Registered Communications Distribution Designer (RCCD).
 - b. Submit the qualifications of the Electrical Testing Laboratory's Field Supervisor to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Electrical Control-Voltage Power Cable Certification:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) acceptable to the Authorities Having Jurisdiction (AHJ), for the location the product is installed in and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended location and/or application.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Test cables upon receipt at the Site.
 - a. Test each pair of unshielded twisted pair (UTP) cable for open and short circuits.

1.06 SITE CONDITIONS

- A. Ambient Conditions:



1. Do not deliver or install unshielded twisted pair (UTP) and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and a temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Cold-Weather Installation:
 - a. Bring cable to room temperature before de-reeling.
 - b. Do not use heat lamps for heating.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

- A. Manufacturers:
 1. Substitution Limitations:
 - a. The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not meant to preclude other manufacturers that may be qualified to provide electrical conductor and cable products.
 - b. Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
 - c. Provide the standard products of a manufacturer regularly engaged in the manufacture of electrical conductor and cable products.
 2. Product Options:
 - a. Product Data:
 - 1) Submit manufacturers Product Data for the conductor and cable products proposed for the Work of this Section to the Program/Project Manager for approval.
- B. Regulatory Requirements:
 1. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work of this Section, including among others the following:
 - a. Phoenix Building Construction Code and Amendments.
- C. Performance:
 1. Surface-Burning Characteristics:
 - a. Provide control-voltage power cables complying with the following surface-burning characteristics as determined by having a qualified testing agency test identical products in accordance with the requirements specified in ASTM E 84:
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 - b. Identify products with appropriate markings of the applicable testing agency.



D. Design Criteria:

1. For sizing pull-boxes, determining the allowable length of conduit and the number of bends between pull points, comply with the requirements specified in TIA-569-B.
2. Load Calculations:
 - a. Prepare cable tray load calculations to show that dead and live loads do not exceed the manufacturer's rating for the tray and its support elements.
3. Shop Drawings:
 - a. Prepare Shop Drawings of the cable tray layout showing the cable tray route in a scale drawing with the relationships between the tray and adjacent structural, electrical, and mechanical elements indicated; and include the following:
 - 1) Vertical and horizontal offsets and transitions.
 - 2) Clearances for access above and to side of cable trays.
 - 3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Submit the Shop Drawings and load calculations to the Program/Project Manager for approval.

E. Materials:

1. Pathways:
 - a. Support of Open Cabling:
 - 1) Provide support for Category 6 cabling, labeled by a nationally recognized testing laboratory (NRTL), and designed to prevent degradation of cable performance and pinch points that could damage the cable.
 - 2) Support brackets with cable tie slots designed so cable ties can be fastened to the brackets, such as the following:
 - a) Lacing bars, spools, J-hooks, and D-rings.
 - b) Straps and other devices.
 - b. Conduit and Boxes:
 - 1) Provide conduits and boxes complying with the requirements specified in Section 16130, Raceways and Boxes.
 - a) Do not use flexible metal conduit.
 - b) Provide outlet boxes no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Backboards:
 - a. Provide 3/4 inch thick, fire-retardant treated plywood backboards, sized 48 inches wide by 96-inches long.
3. Unshielded Twisted Pair (UTP) Cable:
 - a. Provide 100-ohm, four-pair, unshielded twisted pair (UTP) cable complying with the requirements for Category 6 cable specified in TIA/EIA-568-B.2, and formed into 25-pair binder groups covered with a blue thermoplastic jacket.



- 1) Provide unshielded twisted pair (UTP) cable having the mechanical properties specified in ICEA S-90-661.
- 2) Provide unshielded twisted pair (UTP) cable complying with the performance requirements specified in TIA/EIA-568-B.1.
- 3) Provide products to be listed and labeled by a nationally recognized testing laboratory (NRTL) acceptable to the Authorities Having Jurisdiction as complying with the requirements specified in UL 444 and NFPA 70 for the following types:
 - a) Communications, General Purpose: Type CM or Type CMG.
 - b) Communications, Plenum Rated: Type CMP, complying with the requirements specified in NFPA 262.
 - c) Multipurpose: Type MP or Type MPG.
 - d) Multipurpose, Plenum Rated: Type MPP, complying with the requirements specified in NFPA 262.
- b. Manufacturers:
 - 1) Belden CDT Inc.; Electronics Division, www.belden.com
 - 2) Berk-Tek. www.berktek.com.
 - 3) CommScope, Inc., www.commscope.com
 - 4) Prysmian Group, <https://na.prysmiangroup.com/>.
 - 5) Genesis Cable Products; Honeywell International, Inc., www.genescable.com
 - 6) Superior Essex Inc., www.superioressex.com
 - 7) 3M; Electrical Products Division. www.3m.com
 - 8) Tyco Electronics Corp., www.te.com
4. Unshielded Twisted Pair (UTP) Cable Hardware:
 - a. Provide unshielded twisted pair (UTP) cable connecting hardware of the insulation displacement connector (IDC) type, using modules designed for punch-down caps or tools.
 - 1) Provide connecting hardware of the same category or higher for terminating cables.
 - b. Connecting Blocks:
 - 1) Provide 110 style blocks for the number of Category 6 cables terminated on the block, plus 25 percent spares.
 - 2) Provide connecting blocks integral with the connector bodies, including plugs and jacks, where indicated in the Construction Documents.
 - c. Manufacturers:
 - 1) American Technology Systems Industries, Inc.
 - 2) Dynacom Corporation, www.dynacomcorp.com
 - 3) Hubbell Premise Wiring, www.hubbell-premise.com
 - 4) KRONE Incorporated, www.adckrone.com
 - 5) Leviton Voice & Data Division, www.leviton.com
 - 6) Molex Premise Networks, www.molexpn.com
 - 7) Panduit Corp., www.panduit.com
 - 8) Siemon Co. (The)., www.siemon.com



- 9) Tyco Electronics Corp., www.te.com
- 5. Low-Voltage Control Cable:
 - a. Paired Cable:
 - 1) Provide paired cable complying with the requirements for Type CMG specified in NFPA 70, and consisting of one pair, twisted, 16 AWG, stranded (19x29) tinned-copper conductors, unshielded, and PVC insulated and PVC jacketed.
 - 2) Flame Resistance:
 - a) Provide paired cable complying with the requirements for flame resistance specified in UL 1581.
 - b. Plenum-Rated, Paired Cable:
 - 1) Provide plenum-rated, paired cable complying with the requirements for Type CMP specified in NFPA 70, and consisting of one pair, twisted, 16 AWG, stranded (19x29) tinned-copper conductors, unshielded, and PVC insulated and PVC jacketed.
 - 2) Flame Resistance:
 - a) Provide paired cable complying with the requirements for flame resistance specified in NFPA 262.
 - c. Control-Circuit Conductors:
 - 1) Class 1 Control Circuits:
 - a) Provide stranded copper conductor in raceway complying with the requirements for Type THHN-THWN specified in UL 83.
 - 2) Class 2 Control Circuits:
 - a) Provide stranded copper conductor in raceway complying with the requirements for Type THHN-THWN specified in UL 83.
 - 3) Class 3 Remote-Control and Signal Circuits:
 - a) Provide stranded copper conductor complying with the requirements for Type TW or Type TF specified in UL 83.

2.02 ACCESSORIES

- A. Identification Products:
 - 1. Provide identification products complying with the requirements specified in Section 16080, Electrical Identification.
 - a. Comply with the requirements specified in UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
 - 2. Manufacturers:
 - a. Brady Corporation, www.bradyid.com
 - b. HellermannTyton, www.hellermannntyton.us
 - c. Kroy LLC., www.kroy.com
 - d. Panduit Corp., www.panduit.com



2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 - a. Engage a qualified testing agency to evaluate the cables.
 - 2. Unshielded Twisted Pair and Optical Fiber Cable Reel Test:
 - a. Test Procedure:
 - 1) Factory-test unshielded twisted pairs (UTP) and optical fiber cables on reels in accordance with the requirements specified in ANSI/TIA/EIA-568-B.1.
 - 2) Prepare test and inspection reports, and submit them to the Program/Project manager for information.
 - b. Acceptance Criteria:
 - 1) Cable will be considered defective if it does not pass test and inspections.
 - 3. Unshielded Twisted Pair Test:
 - a. Test Procedure:
 - 1) Factory-test UTP cables in accordance with the requirements specified in ANSI/TIA/EIA-568-B.2.
 - 2) Prepare test and inspection reports, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Cable will be considered defective if it does not pass the test and inspections.
 - 4. Multimode Optical Fiber Cable Test:
 - a. Test Procedure:
 - 1) Factory-test multimode optical fiber cables in accordance with the requirements specified in TIA-526-14-A and ANSI/TIA/EIA-568-B.3.
 - 2) Prepare test and inspection reports, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Cable will be considered defective if it does not pass tests and inspections.
- B. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when control-voltage power cables for this Contract are being installed and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Inspect all conduits, junction boxes, electrical vaults, and handholes to verify that they are clean, that they do not have burrs, that conduits are properly aligned, and that they are complete.
 - a. Ensure that on all conduits without threaded hubs, two locknuts are installed.
 - b. Ensure that in all conduits with wires larger than No. 10, bushings are installed.
 - c. Ensure that grounding bushings and fittings are installed at all places specified in Section 16061, Electrical Grounding and Bonding.
 - d. Verify that proper sized boxes are installed.
 - 2. Verify that boxes and conduit fittings conform to the bending requirements specified in Article 314 of NFPA 70 (NEC).
- B. Evaluation and Assessment:
 - 1. Do not begin installing wiring until other work which might cause damage to the wires, cables, or conduits has been completed.
 - a. Correct deficiencies in conduits, junction boxes, electrical vaults, and handholes that have been discovered by inspection.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the control-voltage power cables.
 - 2. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.
- B. Surface Preparation:
 - 1. Perform excavation, trenching, and backfilling, if required, as specified in Section 02316, Trenching and Backfilling.
 - 2. Prepare conduits to receive wire and cable.
 - a. Swab the conduits with a nylon brush and steel mandrel.
 - b. Pre-lubricate the conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.
 - 3. Verify that pulling calculations have been made and are available for long conduit runs and pulls as indicated in this Section.
 - 4. Verify that a means of controlling the pulling tension on the wire or cable is installed on the mechanical assist devices furnished for pulling cable.



3.03 INSTALLATION

- A. Backboards:
 - 1. Install backboards with the 96-inch dimension vertical.
 - 2. Butt adjacent sheets tightly together, and form smooth gap-free corners and joints.
- B. Pathways:
 - 1. Install conduits and wireways in accordance with the requirements specified in Section 16130, Raceways and Boxes.
 - a. Provide manufactured conduit sweeps and long-radius elbows, if possible.
 - 2. Pathway Installation in Equipment Rooms:
 - a. If a single piece of plywood is installed, position conduit ends adjacent to a corner on the backboard; or if multiple sheets of plywood are installed around the perimeter walls of the room position conduit ends in the corner of room.
 - 1) If conduits cannot be located in these positions, install cable trays to route cables.
 - 2) If the conduits enter the room from overhead, secure the conduits to the backboard.
 - b. Extend conduits 3 inches (75 mm) above the finished floor (AFF).
 - c. Provide grounding bushings on metal conduits, and connect the grounding bushings to the grounding system via grounding conductor.
- C. Conductors and Cables:
 - 1. Furnish and install conductors and cables in accordance with the requirements specified in NECA 1, ANSI/TIA/EIA-568-B.1, and Chapter 6, "Cable Termination Practices", in BICSI ITSIMM.
 - 2. Terminate all conductors.
 - a. Do not allow cable containing un-terminated elements.
 - b. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 3. Do not splice cables.
 - a. Do not splice cable between termination, tap, or junction points.
 - 4. Secure and support cables at intervals not exceeding 30 inches; and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Bundle, lace, and train conductors to terminal points without exceeding the manufacturer's limitations on bending radii, but not less than the radii specified in the "Cabling Termination Practices" Chapter in BICSI ITSIM.
 - a. Provide lacing bars and distribution spools.
 - 6. Do not install bruised, kinked, scored, deformed, or abraded cable.
 - a. Remove and discard cable damaged during installation, and replace it with new cable.
 - 7. Pulling Cable:



- a. Pull cable in accordance with the requirements specified in Chapter 4, "Pulling Cable", in BICSI ITSIMM.
 - b. Monitor cable pull tensions.
- D. Unshielded Twisted Pair (UTP) Cable:
 1. Furnish and install unshielded twisted pair (UTP) cable in accordance with the requirements specified in ANSI/TIA/EIA-568-B.2.
 2. Install 110-style insulation displacement connector (IDC) termination hardware unless otherwise indicated.
 3. Do not untwist unshielded twisted pair (UTP) cables more than 1/2 inch from the point of termination to maintain cable geometry.
- E. Control-Circuit Conductors:
 1. Install control-circuit wiring in raceways.
 2. Comply with the requirements specified in Section 16130, Raceways and Boxes.
- F. Separation from Electromagnetic interference (EMI) Sources:
 1. Comply with BICSI TDM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment, provide separation as follows:
 - a. For electrical equipment having ratings less than 2 kVA, provide a minimum separation of 5 inches.
 - b. For electrical equipment having ratings between 2 kVA and 5 kVA, provide a minimum separation of 12 inches.
 - c. For electrical equipment having ratings more than 5 kVA, provide a minimum separation of 24 inches.
 3. Between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment, provide separation as follows:
 - a. For electrical equipment having ratings less than 2 kVA, provide a minimum separation of 2-1/2 inches.
 - b. For electrical equipment having ratings between 2 kVA and 5 kVA, provide a minimum separation of 6 inches.
 - c. For electrical equipment having ratings more than 5 kVA, provide a minimum separation of 12 inches.
 4. Between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures, provide separation as follows:
 - a. For electrical equipment having ratings less than 2 kVA, there is no requirement.
 - b. For electrical equipment having ratings between 2 kVA and 5 kVA, provide a minimum separation of 3 inches.



- c. For electrical equipment having ratings more than 5 kVA, provide a minimum separation of 6 inches.
 - 5. Between cables and electrical motors and transformers rated 5 kVA or 5 HP and larger, provide a minimum separation of 48 inches.
 - 6. Between cables and fluorescent fixtures, provide a minimum separation of 5 inches.
- G. Control Circuit Conductors:
 - 1. Provide control circuit conductors not less than the following minimum sizes for the applications indicated:
 - a. For Class 1 remote-control and signal circuits, provide 14 AWG conductors, minimum.
 - b. For Class 2 low-energy, remote-control, and signal circuits, provide 16 AWG conductors, minimum.
 - c. For Class 3 low-energy, remote-control, alarm, and signal circuits, provide 12 AWG conductors, minimum.
- H. Grounding:
 - 1. For data communication wiring, provide grounding complying with requirements specified in ANSI/J-STD-607-A and with the "Grounding, Bonding, and Electrical Protection" Chapter in BICSI TDMM.
 - 2. For low-voltage wiring and cabling, provide grounding complying with requirements specified in Section 16061, Electrical Grounding and Bonding.
- I. Special Techniques:
 - 1. Firestopping:
 - a. Provide firestopping complying with requirements specified in Section 07850, Through-Penetration Firestopping Systems, and with the following:
 - 1) Comply with the requirements specified in Annex A, "Firestopping" of TIA-569-B.
 - 2) Comply with the requirements specified in the "Firestopping Systems" Article of BICSI TDMM.
 - 2. Identification:
 - a. Identify system components, wiring, and cabling according to accordance with the requirements specified in ANSI/TIA/EIA-606-A.
 - b. Provide system component, wiring, and cabling identification complying with requirements specified in Section 16075, Electrical Identification.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:



- a. Have the Electrical Testing Laboratory (ETL) perform the electrical testing specified for control-voltage power cables in Section 16080, Electrical Testing, and the testing specified herein:
 - 1) Test the cables after termination, but before cross connection.
 - 2) Have the Electrical Testing Laboratory (ETL) furnish test instruments that meet or exceed the applicable requirements specified in ANSI/TIA/EIA-568-B.2.
 - a) Perform tests with a tester that complies with the performance requirements in the "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in the "Measurement Accuracy (Informative)" Annex.
 - b) Use only test cords and adapters that are qualified by the test equipment manufacturer for the channel or link test configuration.
 - b. Unshielded Twisted Pair (UTP) Cabling Tests:
 - 1) Test Procedure:
 - a) Test unshielded twisted pair (UTP) cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors.
 - b) Document the data for each measurement.
 - 2) Acceptance Criteria:
 - a) Unshielded twisted pair (UTP) cabling complying with the performance requirements specified in TIA/EIA-568-B.1, having the proper polarity between conductors, and not having shorts, opens, intermittent faults will be acceptable.
 - c. Connection Block Test:
 - 1) Test Procedure:
 - a) Test the operation of the shorting bars in connection blocks.
 - b) Document the data for each measurement.
 - 2) Acceptance Criteria:
 - a) Connection blocks operating as designed by the manufacturer will be acceptable.
2. Inspections:
 - a. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 1) Inspect cabling terminations to confirm the color-coding for pin assignments, and inspect cabling connections to confirm compliance with requirements specified in ANSI/TIA/EIA-568-B.1.
 - b. Visually inspect unshielded twisted pair (UTP) and optical fiber cable jacket materials for UL or third-party certification markings.
 3. Prepare Control-Voltage Power Cables Test and Inspection Reports.
 - a. Document the data for each measurement.
 - b. Print the data for submission to the Program/Project Manager in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data directly from the instrument to the computer, save it as a text file, and print it, but in either case submit



the Control-Voltage Power Cables Test and Inspection Reports to the Program/Project Manager for information.

B. Non-Conforming Work

1. End-to-end cabling will be considered defective if it does not pass the specified tests and inspections.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16130

RACEWAY AND BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing, energizing, and testing conduit, tubing, and fittings for communication lines and electrical transmission, distribution and service lines.
 - 2. Requirements for providing, connecting, cleaning and protecting electrical pull boxes and junction boxes.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01400 - Quality Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 02582 – Underground Ducts and Manholes.
 - 5. Section 07850 – Through Penetration Firestopping Systems.
 - 6. Section 16061 – Electrical Grounding and Bonding.
 - 7. Section 16070 – Hangers and Supports.
 - 8. Section 16071 – Seismic Controls.
 - 9. Section 16120 – Conductors and Cables.

1.02 REFERENCES

- A. Acronyms and Abbreviations
 - 1. EMT: Electrical metallic tubing.
 - 2. FMC: Flexible metal conduit.
 - 3. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 4. IMC: Intermediate metal conduit.
 - 5. LFMC: Liquid-tight flexible metal conduit.
 - 6. LFNC: Liquid -tight flexible nonmetallic conduit.
 - 7. NBR: Acrylonitrile-butadiene rubber.
 - 8. PVC: Polyvinyl chloride.
 - 9. RGS: Rigid galvanized steel conduit.
 - 10. RNC: Rigid nonmetallic conduit.
- B. Definitions:
 - 1. Standard terminology for raceway and boxes defined in NFPA 70, IEEE C2, and in other reference documents applies to the Work of this Section unless otherwise stated, specified, or noted.
 - 2. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.



3. Withstand: The cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event.

C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI C80.1 – American National Standard for Electrical Rigid Steel Conduit (ERSC).
 - b. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT).
 - c. ANCI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC).
 - d. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).
2. ASTM International (ASTM):
 - a. ASTM A 53/A 53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concretes for Use in Construction and Criteria for Laboratory Evaluation.
 - d. ASTM D 2582 - Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C2– National Electrical Safety Code®.
5. International Organization for Standardization (ISO):
 - a. ISO 9000 – Quality Management Systems – Fundamentals and Vocabulary.
 - b. ISO 10012 - Measurement Management Systems -- Requirements for Measurement Processes and Measuring Equipment.
6. National Electrical Manufacturers Association (NEMA):
 - a. NEMA RN 1 – Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - b. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
 - c. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - d. NEMA TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - e. ANSI/NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.



- f. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
 - g. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- 7. National Electrical Contractors Association (NECA):
 - a. ANSI/NECA 1 – Standard Practice of Good Workmanship in Electrical Contracting (ANSI).
- 8. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
- 9. Society of Cable Telecommunications Engineers (SCTE)
 - a. SCTE 77 – Specification for Underground Enclosure Integrity.
- 10. Underwriters Laboratories, Inc. (UL):
 - a. UL 6 – Electrical Rigid Metal Conduit.
 - b. UL 498 – Attachment Plugs and Receptacles.
 - c. UL 360 – Liquid-Tight Flexible Steel Conduit.
 - d. UL 514A – Metallic Outlet Boxes.
 - e. UL 514B – Fittings for Conduit and Outlet Boxes.
 - f. UL 797 – Electrical Metallic Tubing.
 - g. UL 886 – Standard for Safety Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
 - h. UL 1242 – Electrical Intermediate Conduit.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) Conduit routing plans.
 - b) HVAC, plumbing, and fire suppression items.
 - c) Structural members.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Rigid Polyvinyl Chloride (PVC) conduit.
 - 2) Non-metallic conduit solvent.
 - 3) Electrical Metallic Tubing (EMT).
 - 4) Intermediate Metal Conduit (IMC).
 - 5) Plastic coated rigid galvanized steel conduit.
 - 6) Liquid-tight flexible metal conduit.



- 7) Rigid Galvanized Steel conduit (RGS).
 - 8) Fittings for non-metallic conduit systems.
 - 9) Fittings for metallic conduit systems.
 - 10) Conduit spacers.
 - 11) Heat shrink tubing.
 - 12) Wall and floor penetration seals.
 - 13) Cast outlet boxes for general purpose applications used with steel conduit systems.
 - 14) Cast outlet boxes for general purpose applications used with coated conduit systems.
 - 15) Sheet metal boxes for general purpose applications.
 - 16) Outlet boxes for hazardous locations.
 - 17) Pull boxes for hazardous locations.
 - 18) Equipment and control device enclosures for all areas except outdoor and corrosive locations.
 - 19) Equipment and control device enclosures for outdoor locations.
 - 20) Equipment and control device enclosures for corrosive locations.
 - 21) Ground lug/bus bar.
 - 22) Cold galvanize coating.
 - b. Shop Drawings:
 - 1) Plans, elevations, sections, details, and attachments to other work.
 - 2) Coordination Drawings.
 - 3) Proposed departures from the original design.
 - c. Certificates:
 - 1) Electrical component, device, and accessory certification.
 - 2) Manufacturer seismic qualification certification.
 - d. Delegated Design Submittals:
 - 1) List of the materials proposed to satisfy the requirements of this Section.
 - e. Qualification Statements:
 - 1) Qualifications of the installers.
 - 2) Qualifications of the licensed electricians.
 - 3) Qualifications of the Electrical Testing Laboratory (ETL).
- B. Informational Submittals:
1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Factory test reports as specified for the products provided under this Section.
 - b. Manufacturer's Reports:
 - 1) Manufacturer's comprehensive calculations.
- C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built Record Drawings.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70 (NEC), and to other applicable state, local, and national governing codes and regulatory requirements.
 2. All items installed from utility service poles to the main service panels must be approved by the serving utility, whether electrical service or telephone service.
 - a. To facilitate power utility approval of the items installed from the utility's service poles to the main service panels as specified in Subparagraph 1.05.A.2, submit 4 more copies of the conduit submittals than the number required by Section 01330, Submittal Procedures.
 3. Phoenix Building Construction Code:
 - a. Within buildings, perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
- B. Qualifications:
 1. Installer Qualifications:
 - a. Employ an installation firm with a minimum of 3 years documented experience installing conduit and tubing similar in type and scope to that required by this Contract to install the Work of this Section.
 - b. Employ skilled licensed electricians to supervise the Work of this Section.
 - c. Submit information verifying the installer's and licensed electrician's qualifications to the Program/Project Manager for approval.
 2. Electrical Testing Laboratory (ETL) Qualifications:
 - a. The City will employ an independent testing agency, qualified as specified in Section 01400, Quality Requirements Phoenix to perform the testing required by this Section.
- C. Certifications:
 1. Electrical Component, Device, and Accessory Certification:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these



nationally recognized testing laboratories are not available or unless standards do not exist for the products.

- 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Manufacturer Seismic Qualification Certification:
- a. Submit certification that the enclosures and cabinets, and their mounting provisions including those for internal components, will withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Basis for Certification:
 - a) Indicate whether withstand certification is based on an actual test of the assembled components or on calculations.
 - 2) Include the following:
 - a) Dimensioned outline drawings of equipment units identifying the center of gravity.
 - (1) Locate and describe mounting and anchorage provisions.
 - b) Detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver materials and equipment in a clean condition.
 - a. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.
2. Provide equipment needed for unloading operations, and have such equipment on the Site to perform unloading work when the material and equipment is delivered.
 - a. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.
 - b. In the absence of pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.
 - c. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by the manufacturers.



3. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Handle materials and equipment in accordance with the manufacturer's written instructions.
 2. Store all products whether on-site or off-site, indoors on blocking or pallets.
 3. Follow the manufacturer's written instructions for storing the items.
 4. Except for electrical conduit, store electrical equipment and products under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Substitution Limitations:
 1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
 2. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with the Contract requirements.

2.02 REGULATORY REQUIREMENTS:

- A. Install the electrical Work of this Section in conformance to the wiring methods general requirements of Article 300 in NFPA 70 (NEC), and to all other applicable Articles of NFPA 70 governing wiring methods.
 1. Cut conduit and wireway square, and ream the cut ends according to the requirements of NFPA 70 (NEC) to deburr the openings so that they are not restricted more than cuts made by the material manufacturer.
- B. Within the areas labeled as "hazardous" on the Contract Drawings, only provide equipment, fittings, and wiring as indicated which are approved for Class 1, Division 1, Group D or Class II, Division 1, Group F locations as required by NFPA 70 (NEC) for the type of area in question and as specifically designed for this type of hazardous use.

2.03 DESIGN CRITERIA:

- A. Provide conduit of the type and material shown in Table 16130-1 for the application indicated, or as indicated on the Contract Drawings.



1. In a given location, provide only the type of conduit indicated or scheduled for that location except as modified by Subparagraphs 2.03.A.2, 2.03.A.3, 2.03.A.4, and 2.03.A.5.
2. For conduits embedded in concrete, use rigid galvanized steel (RGS) conduit.
3. Intermediate metal conduit (IMC) and fittings meeting the requirements of Subparagraph 2.04.G.2 may be used wherever rigid galvanized steel is specified.
4. For wall and floor penetrations, use only metallic raceways.
5. Use PVC coated flexible metal conduit and fittings in exposed areas.
6. On conduit that is installed outside, provide a second equipment ground conductor and use fittings with a built-in ground lug for bonding.
7. Provide flexible conduit only to the extent permitted by NFPA 70 (NEC).
 - a. In flexible conduits that do not have an integral ground wire, install a green insulated wire in addition to the neutral wire for grounding purposes.
 - 1) Form a "J" or "S" hook with a drip loop to allow flexibility.
 - 2) Provide a second equipment grounding conductor on outside conduit and provide fittings with built-in ground lug for bonding.
 - b. In exposed areas, use PVC coated flexible metal conduit and fittings.
 - c. Use flexible metal conduit or liquid tight flexible metal conduit for final connection to recessed lighting fixtures and rotating and vibrating equipment.
 - 1) Rotating and vibrating equipment includes such items as transformers, motors, solenoid valves, pressure switches, limit switches, generators, engine-mounted devices, and pipe-mounted devices.
 - 2) For motor connections, do not use a flexible conduit length exceeding 18 inches,
 - 3) For equipment connections, do not use a flexible conduit length exceeding 36 inches.
 - 4) For lighting fixture connections, do not use a flexible conduit length exceeding 72-inches.

Table 16130-1 CONDUIT SYSTEM SELECTION

Location	Condition 1	Condition 2	Conduit Type	Size (Minimum) ¹
Under-Ground	Encased (Red Concrete)	Bends, over 45 degrees in length	PVC Coated Rigid Galvanized Steel or Fiberglass-Reinforced Plastic	1 Inch
		Conduit Risers	PVC Coated Rigid Galvanized Steel	1 Inch



		Conduit within 6-inches of exit from encasement	PVC Coated Rigid Galvanized Steel	1 Inch
		Other	As indicated on the Contract Drawings	1 Inch
Above-Ground	Outside	Wet locations	PVC Coated Rigid Galvanized Steel or Intermediate Metal Conduit	3/4 Inch
		Other	Rigid Galvanized steel or Intermediate Metal Conduit	3/4 Inch
	Inside	Within 6-inches of floor	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Above suspended ceilings	Electrical Metal Tubing	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Flexible Metal Conduit or Liquid-Tight Flexible Metal Conduit	3/4 Inch
		Concealed in Wall	Electrical Metal Tubing	3/4 Inch
		Feeders	Rigid Galvanized Steel	2" and Greater
	Other	Rigid Galvanized Steel	3/4 Inch	
1 No conduit smaller than 3/4-inch trade size is permitted unless indicated otherwise on the approved Shop Drawings.				

- B. Provide conduit fittings made of material identical to that of the conduit system with which they are used.
1. Provide fittings and apparatus as required to construct the approved electrical design.
 - a. Running threads on conduit are not permitted.
 - 1) Where couplings and connectors are required for metal conduits, use approved threaded couplings, compression fittings, and threaded connectors.



- b. Provide conduit unions where necessary to complete a conduit run when neither conduit end can be turned.
 - c. Where conduit and raceway runs cross building expansion joints, make provision for expansion in the conduit and raceway runs.
 - d. Provide sealing fittings with drain fittings in all lower runs and vertical runs.
 - e. Provide sealing covers for junction boxes where required.
 - f. Provide weatherproof conduit hubs on all conduit connections exterior to the building, and on instruments, process equipment, and pump motors.
- C. Product Data:
 - 1. Submit a list of the materials proposed to satisfy the requirements of this Section to the Program/Project Manager for approval.
 - 2. Submit the manufacturer's comprehensive calculations used to determine size requirements for the boxes to the Program/Project Manager for approval.
 - 3. Submit Product Data and catalog cuts of the materials and equipment proposed to be used to satisfy the requirements of this Section to the Program/Project Manager for approval.
 - a. Clearly indicate the usage of each product on the submittal
 - b. Include Product Data for the equipment and material provided under this Section with the Operation and Maintenance Manuals submitted in accordance with the requirements of Section 01780, Closeout Submittals, at Contract closeout.
- D. Shop Drawings:
 - 1. Submit Shop Drawings of the proposed raceway system including plans, elevations, sections, details, and attachments to other work to the Program/Project Manager for approval.

2.04 MANUFACTURED UNITS

- A. Cast Outlet Boxes for General Purpose Applications:
 - 1. For Use with Steel Conduit Systems:
 - a. For use with steel conduit systems, provide small cast steel or cast malleable iron outlet boxes with threaded hubs that meet the NEMA 250 requirements for Type 12 enclosures.
 - b. If covers are indicated or specified, provide cast steel or cast malleable iron covers with neoprene gaskets.
 - 1) Provide captive Type 316 stainless steel mounting screws for the covers.
 - c. If fixture hangers are indicated or specified, provide ball type cast steel or cast malleable iron fixture hangers with neoprene gaskets.
 - 1) Provide captive Type 316 stainless steel mounting screws for the fixture hangers.
 - d. Finish:



- 1) Provide outlet boxes, covers, and hangers with an electroplated zinc coating, followed first by a dichromatic prime, and then by an aluminum polymer finish coating conforming to NEMA FB 1.
 - e. Manufacturers:
 - 1) EGS/Appleton Electric, www.appletonelec.com.
 - 2) EGS/O-Z/Gedney, www.o-zgedney.com.
 - 3) Approved equal.
 2. For Use with Coated Conduit Systems:
 - a. When boxes for use with coated conduit systems are indicated or specified, provide cast outlet boxes as specified for steel conduit systems, but having coatings as specified for the system.
 - 1) Provide a 40 mils thick PVC coating conforming to the requirements of NEMA RN 1 outside, and a 2 mils thick fusion-bonded blue, red, or green urethane coating inside.
 - a) Insure that the color of the PVC coating is uniform throughout the Work of this Contract.
 - 2) For internally threaded openings in the box, provide a 40 mil thick plastic sleeve extending one pipe diameter or 2 inches, whichever is less, beyond the openings with an inside sleeve diameter equal to the outside diameter of the conduit or pipe used.
 - b. Manufacturers:
 - 1) Thomas & Betts, Ocal®, <http://www.tnb.com/pub/en/node/152>.
 - 2) Robroy Industries, www.robroy.com.
- B. Conduit Fittings:
 1. Fittings for Non-Metallic Conduit Systems:
 - a. Provide high impact non-metallic fittings conforming to same requirements as for the non-metallic conduit as specified in Paragraph 2.04.H.
 - b. Non-Metallic Conduit Expansion Fittings:
 - 1) Provide a two-piece nonmetallic, noncorrosive, nonconductive, UL listed expansion fitting.
 - c. Manufacturers:
 - 1) Lamson & Sessions, Carlon®, www.carlon.com.
 - 2) Queen City Plastics, Inc., www.queencityplastics.com.
 - 3) Manhattan Wire, Inc., www.manhattanwire.com
 - 4) Approved equal.
 2. Fittings for Metallic Conduit Systems:
 - a. Construct conduit bodies/fittings from cast malleable iron or cast steel.
 - 1) Provide threaded or compression fittings of the same material of the conduit.
 - b. For PVC coated raceway systems, provide PVC coated fittings of cast malleable iron or cast steel from the same manufacturer that provides the uncoated conduit bodies/fittings.
 - c. Conduit Outlet Bodies:



- 1) Provide malleable iron threaded entry type conduit outlet bodies with neoprene gaskets and cast steel conduit.
- 2) Manufacturers:
 - a) EGS/Appleton Electric, www.appletonelec.com.
 - b) EGS/O-Z/Gedney, www.o-zgedney.com.
 - c) Approved equal.
- d. Conduit Expansion Joints:
 - 1) Provide telescoping sleeve type galvanized, weatherproof, and vapor tight conduit expansion joints designed for 2-inch beyond structural expansion with an insulated bushing and lead-wool packing.
 - 2) Manufacturers:
 - a) EGS/Appleton Electric, www.appletonelec.com.
 - b) EGS/O-Z/Gedney, www.o-zgedney.com.
 - c) Approved equal.
- e. Conduit Unions:
 - 1) Provide conduit unions capable of completing a conduit run when neither conduit end can be turned.
 - 2) Manufacturers:
 - a) EGS/Appleton Electric, UNF and UNY Unions, www.appletonelec.com.
 - b) Thomas and Betts Company, Erickson® Coupling, <http://www.tnb.com/pub/en/node/152>
 - c) Approved equal.
- f. Conduit Outlet Boxes:
 - 1) Provide malleable or cast iron conduit outlet boxes conforming to the requirements of UL 886, and having a cover with O-rings to keep out moisture.
 - 2) Manufacturers:
 - a) EGS/Appleton Electric, GRF outlets and covers, www.appletonelec.com.
 - b) EGS/O-Z Gedney, www.o-zgedney.com.
 - c) Approved equal.
- g. Conduit Device Boxes:
 - 1) Provide malleable iron conduit device boxes with internal grounding screws and conforming to the requirements of UL 498 and UL 514A.
 - 2) Manufacturers:
 - a) EGS/Appleton Electric, FD device boxes, www.appletonelec.com.
 - b) EGS/O-Z Gedney, www.o-zgedney.com.
 - c) Approved equal.
- h. Conduit Sealing Fittings:
 - 1) Provide triple-coated, malleable iron conduit sealing fittings.
 - a) Coat the conduit sealing fittings with zinc electroplate, dichromate, and an epoxy powder coat.



- 2) Provide drain fittings in conduit sealing fittings where required.
 - 3) Provide sealing covers for junction boxes where required.
 - 4) Acceptable Manufacturers:
 - a) EGS/Appleton Electric, www.appletonelec.com.
 - (1) Sealing hubs: ES.
 - (2) Sealing fittings: EYSEF, EYSDEF, and EYD.
 - b) EGS/O-Z Gedney, www.o-zgedney.com.
 - c) Approved equal.
- C. Conduit Spacers
1. Provide non-metallic, interlocking type conduit spacers which snap together to join any combination of intermediate and base units together, both vertically and horizontally.
 2. Manufacturers:
 - a. Underground Devices Inc., www.udevices.com.
 - b. The George-Ingraham Corp.
 - c. Approved equal.
- D. Equipment and Control Device Enclosures:
1. For all areas except outdoor and corrosive locations, provide enclosures with hinged doors that meet the NEMA 250 requirements for Type 1 enclosures, depending on Contract requirements.
 - a. Enclosure Cabinet:
 - 1) Provide sheet steel boxes having continuously welded seams, ground smooth.
 - 2) Provide enclosures having no holes or knockouts.
 - b. Enclosure Door:
 - 1) Provide overlapping sheet steel hinged doors, having a continuous hinge with a removable heavy gauge hinge pin and door clamps with screws to provide a watertight seal or to exclude liquids and contaminants.
 - 2) Provide a means of bonding on the door.
 - c. Door Gasket:
 - 1) Provide an oil resistant door gasket for each box.
 - d. Security:
 - 1) Provide a mechanism for padlocking the enclosure.
 - e. Finish:
 - 1) Provide polyester powder coating applied over phosphatized surfaces.
 - 2) Color: ANSI Z55.1 Number 61 gray.
 - f. Manufacturers:
 - 1) Hoffman, Single-Door NEMA Type 4 Enclosures or NEMA Type 12 and NEMA Type 13 Enclosures, www.hoffmanonline.com.
 - 2) Approved equal.
 2. For outdoor locations, provide enclosures with covers that meet the NEMA 250 requirements for NEMA Type 3R enclosures, and as follows.
 - a. Enclosure Body:



- 1) Fabricate enclosures from galvanized steel sheets; and provide a drip shield on the top, and seam-free sides, fronts, and backs.
- b. Covers:
 - 1) Provide a removable slip-on cover with plated steel captivated screws along the bottom edge for each enclosure.
- c. Security:
 - 1) Provide a mechanism for padlocking the enclosure.
- d. Finish:
 - 1) Provide polyester powder coating applied over phosphatized surfaces.
 - 2) Color: ANSI Z55.1 Number 61 gray.
- e. Manufacturers:
 - 1) Hoffman, Screw Cover Type 3R Enclosures, www.hoffmanonline.com.
 - 2) Or Equal.
3. For corrosive locations, provide enclosures that meet the NEMA 250 requirements for NEMA Type 4X enclosures, and as follows:
 - a. Enclosure Cabinet:
 - 1) For wall mounted enclosures, fabricate enclosure bodies from 14 gauge Type 304 or Type 316L stainless steel sheets; and having continuously welded seams, ground smooth.
 - 2) For floor mounted enclosures, fabricate enclosure bodies from 12 gauge Type 304 stainless steel sheets and enclosure backs from 10 gauge Type 304 stainless steel sheets; and having continuously welded seams, ground smooth.
 - a) Provide stainless steel floor stands, if required.
 - b) Provide stainless steel lifting eyes.
 - 3) Provide a grounding stud on the enclosure body.
 - 4) Provide enclosures having no holes or knockouts.
 - b. Enclosure Doors:
 - 1) For wall mounted enclosures, provide a removable hinged door fabricated from 14 gauge Type 304 or Type 316L stainless steel sheets; and having a rolled lip on three sides and a continuous stainless steel hinge with a removable hinge pin on the fourth side.
 - a) Provide a stainless steel door clamp assembly that assures a watertight seal.
 - 2) For floor mounted enclosures, provide either doors similar to those specified for wall mounted enclosures, or 14 gauge Type 304 stainless steel hinged doors with concealed die-cast hinges that allow 180 degree door opening and easy door removal.
 - 3) Provide a means of bonding on the door.
 - c. Door Gasket:
 - 1) Provide a seamless, foam-in-place, oil-resistant door gasket for each enclosure.
 - d. Security:



- 1) Provide a mechanism for padlocking the enclosure.
 - e. Finish:
 - 1) Provide enclosures with unpainted, Number 4 brushed finish surfaces.
 - f. Manufacturers:
 - 1) Hoffman, Stainless Steel NEMA Type 4X Enclosures and General Purpose Stainless Steel Two-Door Floor-Mount NEMA Type 4X Enclosures, www.hoffmanonline.com.
 - 2) Approved equal.
- E. Ground Lug/Bus Bar:
 1. Provide a copper ground lug or a 1/4-inch by 2-inch copper bus bar in large pull and junction boxes.
- F. Heat Shrink Tubing
 1. Provide all-weather corrosion resistant vinyl plastic heat shrink tubing designed for application on the exterior of metallic conduit to protect against galvanic action, moisture or other deteriorating contaminants.
 2. Manufacturers:
 - a. Tyco Electronics, Raychem, www.raychem.com.
 - b. Manhattan Wire, Inc., www.manhattanwire.com
 - c. Approved equal.
- G. Metallic Conduit:
 1. Electrical Metallic Tubing (EMT):
 - a. Provide electrical metallic tubing (EMT) conforming to the requirements of Article 358 in NFPA 70 (NEC) for materials and uses, ANSI C80.3 and UL 797.
 - b. Provide galvanized steel tubing conduit lengths bearing the manufacturer's trademark.
 - c. Manufacturers:
 - 1) Atkore International, <http://www.atkore.com/brand/conduit/>
 - 2) Wheatland Tube Company, Division of John Maneely Company, www.wheatland.com.
 - 3) Approved equal.
 2. Intermediate Metal Conduit (IMC):
 - a. Provide intermediate metal conduit (IMC) conforming to the requirements of Article 342 in NFPA 70 (NEC) for materials and uses, ANSI C80.6 and UL 1242.
 - b. Fabricate intermediate metal conduit (IMC) from high strength low alloy sheet steel meeting the requirements for ASTM A 568 piping, galvanized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
 - c. Provide conduit furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
 - d. Manufacturers:
 - 1) Atkore International, <http://www.atkore.com/brand/conduit/>



- 2) Wheatland Tube Company, Division of John Maneely Company,
www.wheatland.com.
 - 3) Approved equal.
3. Plastic Coated Rigid Galvanized Steel Conduit:
 - a. Provide plastic coated rigid galvanized steel conduit bearing the UL label.
 - b. Provide base conduit of rigid hot-dip galvanized steel conduit as specified in Subparagraph 2.04.G.5, and of the type indicated, specified, or scheduled to be coated.
 - c. Apply plastic coating in accordance with the following:
 - 1) Apply a 40-mil thick PVC coating on the outside and a 2-mil thick fusion-bonded blue, red, or green urethane coating on the inside, both coatings conforming to the requirements of NEMA RN 1.
 - 2) Have the same manufacturer who produces the hot dip galvanized base conduit factory-apply the plastic coating.
 - 3) Provide plastic coating of one uniform color on all plastic coated rigid galvanized steel conduit provided for this Contract.
 - d. Provide 40-mil thick plastic sleeves to protect internally threaded conduit openings.
 - 1) Provide sleeves with an inside diameter equal to the outside diameter of the conduit/pipe protected by it; and extending either one pipe diameter or 2-inches, whichever is less, beyond the opening.
 - e. Manufacturers:
 - 1) Atkore International, <http://www.atkore.com/brand/conduit/>.
 - 2) Robroy Industries/Perma-Cote, www.permacote.com.
 - 3) Approved equal
4. Liquidtight Flexible Metal Conduit (LFMC):
 - a. Provide PVC coated flexible metal conduit conforming to the requirements of Article 350 of NFPA 70 (NEC) for materials and uses and ANSI/UL 360.
 - b. Provide conduit with interlocking spiral strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
 - 1) Provide conduit with a flexible, galvanized, interlocking spiral strip steel core jacketed with smooth, liquid-tight polyvinyl chloride designed to withstand temperatures from minus 40 degrees Celsius to plus 60 degrees Celsius.
 - c. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer's trademark on each length.
 - d. Furnish an integral continuous copper ground in 1/2-inch through 1-1/4-inch PVC coated flexible metal conduit.
 - e. Manufacturers
 - 1) Electri-Flex Company, Liqueflex®, Type LA, www.electriflex.com.



- 2) ANAMET Electrical, Inc., Anaconda Sealtite®,
www.anacondasealtite.com.
- 3) Approved equal.
5. Rigid Galvanized Steel Conduit (RGS):
 - a. Provide rigid galvanized steel conduit (RGS) conforming to the requirements of Article 344 of NFPA 70 (NEC) for materials and uses, ANSI C80.1, and UL 6.
 - b. Fabricate the RGS from mild steel piping, galvanized or sherardized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
 - c. Provide defect free conduit bearing the UL label, and furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
 - 1) Provide tapered NTP 3/4 inch per foot threads complying with ANSI/ASME B1.20.1.
 - d. Manufacturers:
 - 1) Atkore International, <http://www.atkore.com/brand/conduit/>.
 - 2) Wheatland Tube Company, Division of John Maneely Company, www.wheatland.com.
 - 3) Approved equal.

H. Non-Metallic Conduit:

1. Electrical Plastic Tubing and Conduit:
 - a. Rigid Polyvinyl Chloride (PVC) Conduit:
 - 1) Provide high impact PVC conduit conforming to the requirements of NEMA TC 2 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.
 - a) For indoor use, provide Schedule 40 conduit.
 - b) For encasement in concrete, provide Schedule 40, Type EB or Type DB, conduit tubing.
 - c) Use material that at 78 degrees Fahrenheit has a tensile strength exceeding 5500 psi, a flexural strength exceeding 11,000 psi, and a compressive strength exceeding 800 psi,
 - 2) Provide PVC conduits that are UL listed, labeled, or approved for both underground and above ground use.
 - b. Manufacturers:
 - 1) Lamson & Sessions, Carlon®, www.carlon.com.
 - 2) Queen City Plastics, Inc., www.queencityplastics.com.
 - 3) Manhattan Wire, Inc., www.manhattanwire.com
 - 4) Approved equal.
2. Non-Metallic Conduit Solvent:
 - a. Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D 2564.



- I. Outlet Boxes for Hazardous Locations:
 - 1. For hazardous locations, provide junction boxes and covers that comply with the requirements of UL 886, and are sized according to the installation and NFPA 70 (NEC) requirements.
 - 2. For suspended type or surface mounted conduit runs in hazardous locations, provide outlet boxes having a threaded cover and the proper size and number of tapped conduit hub openings.
 - a. Outlet Box Body:
 - 1) Fabricate outlet box bodies from iron alloy, electrogalvanized and coated with aluminum acrylic paint.
 - 2) Provide threaded access openings that can either accommodate threaded covers that create a seal against the hazard, or that allow the outlet box depth to be increased by using threaded extensions.
 - 3) Provide taper-threaded hubs in the box capable of accommodating threaded rigid or IMC conduit, and having smooth integral hub bushings to protect conductor insulation during wire pulling.
 - 4) Provide an internal ground screw.
 - b. Outlet Box Covers:
 - 1) Provide copper-free aluminum threaded covers with cast “ears”, recesses, or other means to facilitate tightening and removing the cover.
 - a) Provide a neoprene O-ring with the cover.
 - 2) If required, in lieu of providing standard covers provide threaded sealing covers having a removable threaded plug to allow the enclosure to be filled with sealing compound.
 - 3) If required, in lieu of providing standard covers provide threaded covers or canopies capable of mounting pendant type lighting fixtures.
 - 3. Manufacturers:
 - a. Cooper Crouse Hinds Company, GUA and GUR Series Outlet Boxes, www.crouse-hinds.com.
 - b. Approved equal.
- J. Pull Boxes for Hazardous Locations:
 - 1. For hazardous locations, provide pull boxes and covers that comply with the requirements of UL 886, and are sized according to installation and NFPA 70 (NEC) requirements.
 - a. Pull Box Body:
 - 1) Provide copper-free aluminum or iron alloy bodies capable of being factory or field drilled and tapped for conduit entries of the proper size and number.
 - 2) Machine enclosures to accommodate field installed mounting plates.
 - 3) Provide an internal ground lug.
 - b. Pull Box Cover:



- 1) Provide threaded, bolted, or hinged and bolted covers, fabricated from copper-free aluminum or iron alloy, as required.
 - a) Provide bolts for attaching bolted covers.
 - b) Provide hinges for hinged covers.
 - 2) Provide a neoprene gasket with each cover.
 - c. Manufacturers:
 - 1) Cooper Crouse Hinds Company, GUB and EJB Series Junction Boxes, www.crouse-hinds.com.
 - 2) Approved equal.
- K. Sheet Metal Boxes for General Purpose Applications:
 1. For general purpose applications in dry locations, provide small sheet steel pull and terminal boxes and covers that meet the NEMA 250 requirements for NEMA Type 12 enclosures with continuously welded and ground smooth seams, and having no holes or knockouts.
 - a. Cover:
 - 1) Provide overlapping sheet steel screw covers with captivated screws for each box.
 - 2) Provide a means of bonding on the cover.
 - b. Gasket: Provide an oil resistant cover gasket for each box.
 - c. Mounting Brackets:
 - 1) Provide 12 gauge steel wall-mounting brackets.
 - d. Finish:
 - 1) Provide polyester powder coating applied over phosphatized surfaces.
 - 2) Color: ANSI Z55.1 Number 61 gray.
 2. Manufacturers:
 - a. Hoffman, Screw Cover SC Junction Boxes, www.hoffmanonline.com.
 - b. Approved equal.
- L. Wall and Floor Penetration Seals
 1. Provide watertight mechanical seals capable of holding up to 20 psig, and sealing against water, soil, and backfill material.
 2. Manufacturers:
 - a. Pipeline Seal & Insulator, Inc., Thunderline/Link-Seal, www.linkseal.com.
 - b. Flexicraft Industries, PipeSeal, <http://flexicraft.com>.
 - c. Approved equal.

2.05 FINISHES

- A. Cold Galvanized Coating:
 1. Provide a cold galvanized coating to provide protection against corrosion by forming an insoluble zinc salt barrier from a cathodic reaction when the coating is damaged by abrasion and exposed to weather.
 - a. Provide a single component pre-mixed liquid organic zinc compound producing 95 percent zinc in the dry film.



- b. Provide a coating that bonds to clean iron, steel, or aluminum through electrochemical action.
 2. Acceptable Manufacturers:
 - a. ZRC. Worldwide, www.zrcworldwide.com.
 - b. Approved equal.

2.06 SOURCE QUALITY CONTROL

- A. Tests:
 1. Submit factory test reports as specified for the products in this Section to the Program/Project Manager for information.

PART 3 EXECUTION

3.01 INSTALLERS

- A. Install the work of this Section only under the supervision of licensed electricians.

3.02 EXAMINATION

- A. Verification of Conditions:
 1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
 - a. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.
 2. Verify that conduit stub-ups to be mated with electrical boxes and enclosures are the correct type and size, and are at the proper location.
 3. Inspect the condition of existing conduit that is required for the Work of this Section.
 4. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
 - a. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.
 5. Layout the electrical work of this Section to suit actual field measurements.
- B. Evaluation and Assessment:
 1. After carefully investigating structural and finish conditions and other in-place construction work, prepare and submit detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
 - a. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.



- b. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
- c. Include plan and profile views of duct banks.
- d. Indicate the location and details of conflicting utility construction and slopes.
- e. Submit these Shop Drawings to the Program/Project Manager for approval prior to performing the Work of this Section.

3.03 PREPARATION

- A. Hangers and Supports:
 1. Install auxiliary support structures, anchors, and fasteners as specified in Section 16070, Hangers and Supports.
 - a. Mount or suspend conduit and wireway systems directly on structural members of the structures and walls.
 - b. Securely attach anchors into walls.
 2. At all conduit attachments, allow space between the mounting surfaces and the conduit by providing U-channel supports, clamp-backs, or spacers.
 3. Attach wall-mounted conduit runs close to the walls following the contour of the walls, parallel to the walls and other lines except at bends.
- B. Structure Penetrations:
 1. Make penetrations in existing concrete structures by core-drilling.
 - a. Drill the penetrations true, clean, and free from spalling.
 2. At penetrations through fire rated floors, walls, and similar assemblies, provide approved firestopping as specified in Section 07850, Through Penetration Firestopping Systems.
 3. Make floor penetrations as detailed on the Contract Drawings.
 - a. Seal all conduit penetrations through floor slabs on grade in buildings with a floor penetration seal.
 4. Install a wall penetration seal at all wall penetrations.
 - a. Size wall penetrations to accommodate the conduit outside diameter plus either 1/4 inch or a hole allowance to allow the installation of the wall penetration seal.
 5. For conduits that enter rooms from concrete floors or masonry, provide corrosion protection by using an RGS or PVC coated conduit that extends from 12 inches inside the concrete or masonry to at least 6 inches into the room.

3.04 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to the products, except where requirements on the Contract Drawings or herein are stricter.



- B. Fabricate and install conduit and wireway systems in accordance with accepted electrical trade standard practice.
1. Conduit Bends:
 - a. Avoid bending conduits as much as possible and practical.
 - 1) If bends are made, use an approved conduit bending tool or machine to make the bends.
 - b. Install not more than the equivalent of three 90-degree bends in any conduit run except for communication conduits, for which fewer bends are allowed.
 2. Pull Wires:
 - a. Install pull wires in empty raceways.
 - 1) Use monofilament plastic line with not less than 200 pound tensile strength.
 - 2) Leave at least 12 inches of slack at each end of pull wire.
 - 3) For 3/4-inch trade size and smaller, install raceways in maximum lengths of 50 feet.
 - 4) For 1-inch trade size and larger, install raceways in maximum lengths of 75 feet.
 - 5) Install pull wires with a maximum of two 90-degree bends or equivalent for each length of raceway, unless the Contract Drawings show stricter requirements.
 - a) Where necessary to comply with this requirement, separate lengths with pull or junction boxes or terminations at distribution frames or cabinets.
 3. All conduit shall be painted to meet Aviation Design Standards for electrical, fire alarm, communications, and control conduits.
 4. Raceway Sealing Fittings:
 - a. Install raceway sealing fittings at suitable, approved, and accessible locations, and fill them with a listed sealing compound.
 - 1) For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
 - 2) Install raceway fittings where conduits pass from warm to cold locations, such as at boundaries of refrigerated spaces and where otherwise required by NFPA 70.
 5. Expansion Joint Fittings for Rigid Non-Metallic Conduit:
 - a. Where the environmental temperature changes for rigid non-metallic conduit may exceed 30 degrees Fahrenheit, install expansion joint fittings in each aboveground run having a straight-run length exceeding 25 feet.
 - 1) Install expansion joint fittings for each of the following locations, and provide the type and quantity of fittings that will accommodate the temperature change listed for the location:
 - a) Outdoor Locations Not Exposed to Direct Sunlight: 125 degree Fahrenheit temperature change.
 - b) Attics: 135 degree Fahrenheit temperature change.



- b. Install fittings that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree Fahrenheit of temperature change.
 - c. Install each expansion joint fitting with the position, mounting, and piston setting selected according to the manufacturer's written instructions for conditions at the specific location at the time of installation.
 - 6. Installing Rigid Galvanized Steel (RGS) and PVC Coated Conduit:
 - a. Install RGS and PVC coated conduit using methods and techniques recommended by the conduit manufacturer.
 - b. Threading Conduit:
 - 1) Field thread the conduits in accordance with the manufacturer's instructions.
 - a) For PVC coated conduit, first neatly cut the coating off at the proposed end of the threads using a cylindrical guide, oversized to fit over the plastic coating.
 - b) Do not damage or remove the coating beyond the proposed end of the threads.
 - 2) Once the threading operation is complete, protect the newly cut threads against corrosion by applying a "sealing" compound as recommended by the manufacturer.
 - c. Assembling Rigid Galvanized Steel (RGS) and PVC Coated Conduit Fittings:
 - 1) Use PVC coated conduit bodies, clamps, supports, accessories, and fittings with coated conduit systems.
 - 2) Just prior to assembling each conduit joint, apply the conduit manufacturer's touch-up compound to the end of the conduit in the area normally covered by the fitting sleeve.
 - 3) Use cloth or other material over strap type wrenches to protect the coating while tightening conduits.
 - 7. Locations Subject to Moisture or Vibration:
 - a. At locations subject to moisture or vibration, use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
 - 8. Crossing Structural Expansion Joints
 - a. Where conduit crosses expansion joints, provide weather tight expansion and deflection fittings and bonding jumpers.
 - 1) Arrange the raceways to cross building expansion joints perpendicular to the expansion fittings and exceed 2" beyond the maximum structural expansion joint.
 - 2) Support expansion conduit from either side of the expansion joint to allow movement of the joint and not impede on the structural expansion joint.

C. Exposed Work:



1. In exposed work, run conduit and raceway parallel to centerlines and structure surfaces; or perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings.
2. Maintain at least 6 inches clearance between conduit and raceway runs and pipes, ducts, and flues of mechanical systems.
3. If a portion of a metallic conduit run, whether plastic-coated or not, extends above grade or is otherwise exposed to personnel, ensure that the conduit is properly bonded to an equipment grounding conductor at both ends.
4. Install the equipment grounding conductor either inside or outside the box.

D. Concealed Work:

1. When performing electrical work in concealed spaces, provide the same quality workmanship as in exposed work.
2. Conceal conduits and raceways in the structure's construction where practicable unless otherwise indicated on the Contract Drawings or required by the Program/Project Manager.
 - a. Group conduit and raceway runs in concealed work as much as practical to avoid congesting the concealed spaces.
 - b. Do not weaken the structure by excessive or unnecessary cutting.
 - 1) Only make cuts into the structure's construction in conformance to the applicable building codes.
3. Conduits and Raceways Embedded in Concrete Slabs:
 - a. Separate multiple conduits encased together by not less than 2 inches of concrete.
 - b. Locate conduit installed in floor slabs within the reinforced area of the slab.
 - 1) Run conduit larger than 1 inch trade size parallel or at right angles to the main reinforcement.
 - 2) Where conduit is perpendicular to reinforcement, place conduit close to the slab supports.
 - c. Where conduit crosses expansion joints, provide weather tight expansion and deflection fittings and bonding jumpers.
 - 1) Arrange the raceways to cross building expansion joints perpendicular to the expansion fittings that exceed 2" beyond the expansion joint.
 - d. Before rising above the floor, change from electrical metallic tubing to rigid nonmetallic conduit, Type -40-PVC, rigid steel conduit, or intermediate metal conduit.
4. Below Grade Conduit:
 - a. Install below grade conduit in conformance with the requirements of Section 02582, Underground Ducts and Manholes.
 - 1) For conduits that pass under building support walls, provide a minimum of 3 inches of concrete encasement all around.
 - 2) For underground and concrete encased duct banks, provide non-metallic conduit spacers.



- a) Provide sufficient space to allow pouring the concrete envelope without displacing or shifting the individual conduits.
 - b) Encased duct banks shall be provided with red dye.
 - b. Install conduit spacers at intervals not exceeding 5 feet.
- E. Hazardous Locations:
 - 1. In hazardous locations, engage at least 5 full threads on conduit connections to couplings and fitting hubs.
 - a. Coat the threads with a sealing compound that makes the connections gas tight.
 - 2. Properly install sealing fittings at all locations required in accordance with code regulations.
- F. Junction Boxes and Pull Boxes:
 - 1. General Purpose Applications:
 - a. For general purpose applications in dry locations, provide small sheet steel pull and terminal boxes that meet the NEMA 250 requirements for NEMA Type 12.
 - b. Provide boxes that are fabricated from the same type of material as the conduit with which the boxes are used.
 - 2. Hazardous Locations:
 - a. Provide junction boxes rated for the hazard classification of the area where they are installed, whether explosion proof, dust-ignition proof, rain-tight, wet locations, watertight, or other classification.
- G. Equipment and Control Device Enclosures:
 - 1. For all areas except outdoor and corrosive locations, provide enclosures that meet the NEMA 250 requirements for Type 1 enclosures, depending on Contract requirements.
 - 2. For outdoor locations, provide enclosures with covers that meet the NEMA 250 requirements for NEMA Type 3R enclosures.
 - 3. For corrosive locations, provide enclosures that meet the NEMA 250 requirements for NEMA Type 4X enclosures.
- H. Boxes for Electrical Outlets and Devices:
 - 1. Install boxes for electrical outlets and devices level and plumb within 1/16-inch of vertical or horizontal over the length of the box.
 - 2. Install device boxes at a uniform height as indicated on the Contract Drawings.
 - a. Mount all adjacent boxes in alignment at the same mounting height.
 - b. Mount outlet boxes for equipment within 18-inches of the equipment power connection.
 - 3. Do not install flush mounting boxes back-to-back in walls.
 - a. Provide a minimum separation of 6 inches (150 mm).
 - b. Provide a minimum separation of 24inches (600 mm) s in acoustic rated walls.



4. When installing boxes outside or to exposed conduit in unfinished areas, provide cast boxes.
 - a. Mount these boxes on spacers to be 1/8-inch from wall unless box has built-in raised pads to perform the same function.
5. When installing boxes for single devices, two devices, or wall outlets, install 4-inch square boxes with appropriate plaster rings.
 - a. Space boxes on opposite sides of the wall 6 inches apart.
 - b. Set plaster rings flush or to protrude less than 1/16-inch from the wall.
 - c. Openings for boxes in finished walls must be within 1/16-inch of the box.
 - 1) Correct all oversize openings in accordance with the specifications for the wall material.
6. Support cast boxes for outlet and device using one of the following methods:
 - a. Mount the boxes directly to the structure using 4 or more anchors.
 - 1) Attach mounting screws to feet located outside of the box interior.
 - 2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
 - b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
 - c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.
- I. Boxes for Other than Electrical Outlets and Devices:
 1. Accurately punch holes for conduit openings using a hydraulic punch and punches sized for the conduit to be installed.
 2. Install a conduit breather in the top of the box and a conduit drain fitting in the bottom of all boxes not located in bone-dry areas that are at least 100 feet from a hose-bib.
 3. Support boxes for other than electrical outlets and devices using one of the following methods:
 - a. Mount the boxes directly to the structure using 4 or more anchors.
 - 1) Attach mounting screws to feet located outside of the box interior. or seal the screw holes to prevent water penetration.
 - 2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
 - b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
 - c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.
 - d. Mount the box on U-channel and structural supports.
- J. Interface with Other Work:
 1. Wiring:
 - a. Install wiring and cable in conduit and boxes as indicated in Section 16120, Conductors and Cables.



- b. Prior to the installation of any wire, verify that the conduit is clean and free of debris.
 2. Ground conduit and boxes in conformance with Section 16060, Grounding and Bonding.
 - a. Install a separate ground conductor for 1-1/2-inch through 4-inch PVC coated flexible metal conduit.

3.05 REPAIR/RESTORATION

- A. Touch up damaged coatings on electrical boxes and enclosures
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.06 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Site Tests:
 - a. Test all boxes to verify that they are properly connected to the grounding system.
 2. Inspections:
 - a. Inspect installed conduit runs for obstructions, proper support, proper grounding, and completeness.
 - b. Record the actual installed elevations and locations of conduit and tubing on as-built record drawings specified in Section 01780, Closeout Submittals.
 - c. Inspect flush boxes to verify that the opening between the box and the wall finish is less than 1/16-inch.
 - d. Inspect flush boxes to verify that each box is flush with the wall, or protrudes less than 1/16-inch, and is not set behind the wall surface.
 - e. Inspect surface mounted boxes to verify that they are level and plumb within 1/16-inch as specified.
 - f. Record the actual installed elevations and locations of duct banks and the as-found locations of conflicting utility lines on the as-built record drawings specified in Section 01780, Closeout Submittals, and submit the record drawings.
 - g. Record the actual installed elevations and locations of pull and junction boxes on as-built record drawings specified in Section 01780, Closeout Submittals.
- B. Non-Conforming Work
 1. Do not install crushed or deformed conduit, and remove crushed or deformed conduit from the Site.



3.07 CLEANING

- A. Remove dirt, debris, and other obstructions from existing conduit required for the Work of this Section by blowing out and mandreling the conduits as applicable.
- B. Waste Management and Disposal:
 - 1. As the electrical work is completed during the Contract, and at intervals as directed by the Program/Project Manager, clear the Site of all rubbish or debris, and of extraneous materials.
 - 2. Dispose of waste materials off-site in a legal manner.

3.08 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16134

CABLE TRAYS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cable trays and accessories of the following types:
 - a. Center hung cable trays.
 - b. Ladder cable trays.
 - c. Trough cable trays.
 - d. Corrugated solid bottom cable trays.
 - e. Channel cable trays.
 - f. Wire basket cable support systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01732 - Cutting and Patching.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 07842 - Fire-Resistive Joint Systems.
 - 6. Section 07850 - Through Penetration Firestopping Systems.
 - 7. Section 16061 - Electrical Grounding and Bonding.
 - 8. Section 16062 - Communications Grounding and Bonding.
 - 9. Section 16070 - Hangers and Supports.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. EGC: Equipment Ground Conductor.
 - 2. HDGAF: Hot dipped galvanized after fabrication.
 - 3. PGSTL: Milled galvanized steel.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.



3. Wire Basket Support Systems: Wire supports including, but not limited to, straight sections of continuous wire mesh, and field formed horizontal and vertical bends, tees, drop outs, supports, and accessories.

C. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A 510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - c. ASTM A 510M – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel [Metric].
 - d. ASTM A 580/A 580M – Standard Specification for Stainless Steel Wire.
 - e. ASTM A 641/A 641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - f. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - g. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - h. ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - i. ASTM B 766 - Standard Specification for Electrodeposited Coatings of Cadmium.
 - j. ASTM D 769 – Standard Specification for Black Synthetic Iron Oxide.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
 - b. ANSI/NECA/NEMA 105 – Standard for Installing Metal Cable Tray Systems.
5. National Electrical Manufacturers Association (NEMA):
 - a. NEMA VE 1 - Metal Cable Tray Systems.
 - b. NEMA VE 2 - Cable Tray Installation Guidelines.
6. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance.
7. SAE International™ (SAE):
 - a. SAE J405 – Chemical Composition of SAE Wrought Stainless Steels.



8. Underwriters Laboratories, Inc. (UL):
 - a. UL Online Certifications Directory, <https://www.ul.com/ul-databases-and-directories/>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate cable tray installation with the other electrical Work so the installation of cable tray runway is properly interfaced with and does not delay the other work.
 2. Coordination Drawings:
 - a. Prepare and submit Coordination Drawings to the Program/Project Manager for approval.
 - 1) Prepare plans for tight areas, such as electrical rooms, drawn to scale, on which the following items are shown and coordinated with each other, based on input from the installers of the items involved:
 - a) Other systems installed in same space as cable trays.
 - b) Mechanical and electrical equipment, and other miscellaneous items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and similar items.
 - 2) Show the following items for this Contract drawn to scale, and coordinate them with each other:
 - a) HVAC, plumbing, and fire suppression items.
 - b) Conduit routing plans.
 - c) Structural members.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cable trays, fittings, and accessories.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) System layout drawings.
 - c. Certificates:
 - 1) Electrical listing and labeling quality verification.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:



- 1) Cable tray manufacturer's instructions for storing, handling, protecting, and examining the cable trays.
 - 2) Cable tray manufacturer's installation instructions.
 - 3) Wire basket cable support system manufacturer's instructions for field-forming fittings.
 - b. Manufacturer's Reports:
 - 1) Manufacturer's test reports.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) As-built drawings recording the actual routing of the cable trays and the locations of supports.

1.05 QUALITY ASSURANCE

- A. Certifications:
 1. Electrical Listing and Labeling:
 - a. The cable tray products, particularly splicing assemblies, must meet the requirements of Underwriters Laboratories Inc.[®].
 - 1) Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 2) Provide products marked with their intended use or classification.
 - a) The UL Mark on the product will be accepted as evidence of compliance.
 - b. Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - 1) Such evidence may consist of either a printed mark on the data or a separate listing card.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver wire basket wire support systems and components carefully to avoid breakage, bending, and scoring finishes.
- B. Storage and Handling Requirements:
 1. Examine, store, handle, and protect cable trays and accessories as recommended by the cable tray manufacturer.



- a. Submit the cable tray manufacturer's instructions for storing, handling, protecting, and examining the cable trays to the Program/Project Manager for information.
 2. Store cable trays and accessories in their original cartons, and in a clean dry space.
 3. Protect cable trays from the weather and construction traffic.
- C. Packaging Waste Management:
1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 CABLE TRAY WIRE SUPPORT SYSTEMS

- A. Manufacturers:
1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for construction and installation of cable tray and cable channel systems in Article 318 in NFPA 70.
- C. Design Criteria:
1. Locations and Arrangements:
 - a. The plans, schematics, and diagrams on the Contract Drawings indicate the general location and arrangement of the cable tray systems.
 - 1) The locations and arrangements shown indicate the general route of the cable tray systems, and the data presented is as accurate as preliminary surveys and planning can determine until the final equipment selection is made.



- b. The exact routing, locations, distances, and levels will be governed by actual field conditions and final equipment selections.
 - 1) Allow sufficient space around the cable trays to permit access for installing and maintaining cables.
 - 2) Install the cable tray systems as indicated unless deviations to the layout are approved by the Program/Project Manager on the Coordination Drawings.
 - 2. Working (Allowable) Load Capacity:
 - a. Except for channel type cable trays and wire basket type cable support systems, provide cable trays designed so the working load capacities and spans are in compliance with the requirements specified in section 4.8, section 5.2, and Table 1 in NEMA VE 1.
 - b. NEMA Load/Class Designations:
 - 1) Provide ladder type cable trays, trough type cable trays, and corrugated solid bottom type cable trays having NEMA Load/Class designations of 12A, 12B, 12C, 20A, 20B, or 20C as indicated on the Contract Drawings.
 - c. Provide cable trays designed so the tray deflections do not exceed the manufacturers published engineering data for the Project's cable tray working load capacity and minimum support span requirements.
 - 3. Safety Factor:
 - a. Except for channel type cable trays and wire basket type cable support systems, provide cable trays designed using a minimum load capacity safety factor of 5 in accordance with the requirements specified in Design Manual.
 - 4. Product Data:
 - a. Prepare Product Data for the cable trays, fittings, and accessories including, but not limited to, the types of cable trays, materials, finishes, dimensions including inside depths, connector assemblies, clamp assemblies, connector plates, splice plates, and splice bars.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 - 5. Shop Drawings:
 - a. Prepare Shop Drawings consisting of system layout drawings showing accurately scaled components, part numbers, tray types, dimensions, NEMA class, support points, finishes, connector assemblies, clamp assemblies, brackets, splice plates, splice bars, grounding clamps, hold down plates, and accessories.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
- D. Materials:
 - 1. Provide cable trays fabricated from the materials indicated on the Contract Drawings and in compliance with the requirements specified in section 4.1 and section 4.2 of NEMA VE 1.
 - 2. Wire Materials and Finishes:



- a. Provide cable tray sections, fittings, and accessories fabricated from corrosion resistant metal wire materials or metal wire materials with a factory applied corrosion resistant finish as follows:
 - 1) Electro-Plated Galvanized Steel Wire:
 - a) Fabricate straight sections from carbon steel wire complying with the mechanical properties specified for Grade 1008 steel in ASTM A 510 at a minimum, and that are electro-plated with zinc in accordance with the requirements for a Type III Finish and an SC-1 Service Condition specified in ASTM B 633.
 - 2) Hot Dipped Galvanized Steel Wire:
 - a) Fabricate straight sections from carbon steel wire complying with the mechanical properties specified for Grade 1008 steel in ASTM A 510 at a minimum, and that are hot dipped galvanized after fabrication in accordance with the requirements specified in ASTM A 123/A 123M.
 - 3) Pre-Galvanized Carbon Steel Wire:
 - a) Fabricate straight sections from pre-galvanized carbon steel wire complying at a minimum with the mechanical properties specified in ASTM A 641/A 641M.
 - 4) Stainless Steel Wire:
 - a) Fabricate straight sections and accessories from SAE Type 304L (UNS S30403) and SAE Type 316L (UNS S31603) stainless steel wire complying with the composition requirements specified in SAE J405, and complying with the mechanical properties specified in ASTM A 580/A 580M at a minimum.
 - 5) Black Oxide Finish:
 - a) Manufacture certain steel support accessories and miscellaneous hardware to have a black oxide finish complying with the requirements specified in ASTM D 769.
 - 6) Black Powder Coat Finish:
 - a) Powder coat steel straight sections with an average black paint thickness within the range of 1.2 mils (30 microns) to 3.0 mils (75 microns).

E. Cable Tray Types:

- 1. Center Hung Cable Trays:
 - a. Provide prefabricated metal cable tray structures consisting of one longitudinal center hung rail with individual rungs.
 - 1) Construct cable tray rails and rungs from copper free aluminum Alloy 6063.
 - 2) Construct fittings and accessories from a corrosion resistant aluminum alloy that is compatible with aluminum Alloy 6063, such as Alloy 5052 or Alloy 3003.
 - b. Lengths of Straight Sections:



- 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - a) The manufacturer's standard lengths of must include 10 feet (actual 118-1/2 inches) and 12 feet (actual 142-1/2 inches), not including their connectors if they are attached.
- 2) Provide straight section lengths that are greater than or equal to the support span length.
- 3) Provide straight section lengths so that at most only one splice joint occurs between any two cable tray supports.
- c. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard ladder tray selections must include full width and half width bottom rung configurations.
 - a) The manufacturer's standard widths must include 6 inches, 9 inches, 12 inches, 18 inches, and 24 inches in compliance with the requirements specified in Section 4.3.3 of NEMA VE 1.
- d. Center Rails:
 - 1) Provide cable tray center rails consisting of a 1-1/2 inches wide by 3.76 inches high hollow aluminum Alloy 6063 tube.
- e. Rungs:
 - 1) Provide rungs consisting at a minimum of a 5/8 inch wide by 5/8 inch deep hollow aluminum Alloy 6063 tube with a reinforcing rib as specified by the manufacturer.
 - 2) Weld the rungs to the center rail so each rung is welded in at least 2 places in accordance with the manufacturer's specifications.
 - a) Do not attach standard tray rungs to the center rail by mechanical means.
 - 3) Rung Height:
 - a) Provide actual rung heights as indicated on the Contract Drawings.
 - (1) The manufacturer's standard cable tray rung heights must include 3 inches, 4 inches, or 6 inches in compliance with the requirements specified in Section 4.3.4.2 of NEMA VE 1.
 - 4) Rung Spacing:
 - a) Space rungs on straight tray sections 6 inches, 9 inches, or 12 inches apart on center as indicated on the Contract Drawings.
 - (1) The manufacturer's standard rung spacing must include 6 inches, 9 inches, or 12 inches.
 - b) Do not allow the distance between rungs on fittings to exceed the rung spacing and tolerances for straight tray.
- f. Tray Fittings:



- 1) Provide the types and quantities of tray fittings indicated on the Contract Drawings.
- 2) Fabricate cable tray fittings from the same material as the straight tray sections.
- g. Connectors:
 - 1) Provide one tray connector with hardware for each straight tray section.
 - 2) Connector Hardware:
 - a) Provide zinc plated 3/8-inch diameter hex bolts and serrated-face flanged hex nuts which do not need a washer.
 - b) Protect the connector hardware finish against corrosion.
 - 3) Connector Splices:
 - a) Provide connector splices having an electrical resistance of less than 0.00033 ohms.
 - 4) Expansion Connectors:
 - a) Provide expansion connectors capable of providing for tray expansion of at least 1 inch greater than structure expansion joint, and located as shown on the Contract Drawings or as required to prevent damage to the tray system from thermal expansion and contraction in accordance with NEMA VE-1.
 - b) Install grounding bonding jumpers at all expansion connectors.
- h. Manufacturers:
 - 1) Cablofil/Legrand®, PW Industries, <http://www.pwindustries.com>.
 - 2) Approved equal.
2. Ladder Cable Trays:
 - a. Provide prefabricated metal cable tray structures consisting of 2 longitudinal side members connected by individual transverse members or individual rungs.
 - 1) The manufacturer's standard ladder cable tray selections must include both flange in and flange out configurations.
 - 2) For ladder type cable trays indicated to receive a mill galvanized (PGSTL) coating on the Contract Drawings, apply the coating at the steel mill in accordance with the requirements specified in ASTM A 924/A 924M and ASTM A 653/A 653M.
 - 3) For ladder type cable trays indicated to receive a hot dipped galvanized finish after fabrication (HDGAF) on the Contract Drawings, apply the coating in accordance with the requirements specified in ASTM A 123/A 123M.
 - b. Lengths of Straight Sections:
 - 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - a) The manufacturer's standard lengths must include 12 feet and 20 feet, not including their connectors if they are attached.



- 2) Provide straight section lengths that are greater than or equal to the support span length.
- 3) Provide straight section lengths so that at most only one splice joint occurs between any 2 cable tray supports.
- c. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard ladder tray selections must include full width and half width bottom rung configurations.
 - a) The manufacturer's standard widths must include 6 inches, 9 inches, 12 inches, 18 inches, 24 inches, 30 inches, and 36 inches in compliance with the requirements specified in Section 4.3.3.1 of NEMA VE 1.
- d. Side Rail Height:
 - 1) Provide actual side rail heights as indicated on the Contract Drawings.
 - a) The manufacturer's standard side rail heights must include 3 inches, 4 inches, 6 inches, and 7 inches in compliance with the requirements specified in Section 4.3.4.3 of NEMA VE 1.
- e. Side Channels:
 - 1) Provide side channel members configured as 'C' channels having a top flange measuring at least 1-inch.
- f. Rungs:
 - 1) Provide rungs that are a minimum of 1 inch wide.
 - 2) Weld the rungs to the side rails.
 - a) Do not attach standard tray rungs to the side rails by mechanical means.
 - 3) Fabricate the rungs from the same material as the side rails.
 - 4) Rung Spacing:
 - a) Space rungs on straight tray sections 6 inches, 9 inches, or 12 inches apart on center as indicated on the Contract Drawings.
 - (1) The manufacturer's standard rung spacing must include 6 inches, 9 inches, or 12 inches.
 - b) Do not allow the distance between rungs on fittings to exceed the rung spacing and tolerances for straight tray as measured at the center of the fitting.
- g. Tray Fittings:
 - 1) Provide the types and quantities of tray fittings indicated on the Contract Drawings.
 - a) Fittings for tangent sections of NEMA Class 12A, NEMA Class 12B, or NEMA Class 12C trays, must be at least 2 inches.
 - b) Fittings for tangent sections of NEMA Class 20A, NEMA Class 20B, or NEMA Class 20C trays, must be at least 5 inches.
 - 2) Fabricate cable tray fittings from the same material as the straight tray sections.



- 3) The manufacturer's standard fittings must include at a minimum the following types:
 - a) Horizontal elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles.
 - b) Vertical elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles with inside and outside radius options.
 - c) Horizontal adjustable elbow fittings having an adjustable angle.
 - d) Horizontal and vertical tee fittings having a branch at a 90-degree angle.
 - e) Horizontal wye fittings having a branch at a 45-degree angle.
 - f) Horizontal and vertical cross fittings having branches at 90-degree angles.
 - g) Horizontal Reducers:
 - (1) Straight Type:
 - (a) Reducer fitting having 2 symmetrical offsets from the centerline of the fitting.
 - (2) Right Hand Type:
 - (a) Reducer having a straight side on right side of the fitting when viewed from the large tray width side.
 - (3) Left Hand Type:
 - (a) Reducer having a straight side on left side of the fitting when viewed from the large tray width side.
 - h) Fitting Radius:
 - (1) Provide fittings having a nominal bend radius of [12][24][36] inches measured on the smallest side as indicated on the Contract Drawings.
 - (2) Provide fittings having a bend radius appropriate for the allowable bending radius of the cables to be installed in the fitting.
 - (3) The manufacturer's standard fitting radii must include 12-inch, 24-inch, 36-inch, and 48-inch radii in accordance with the requirements specified in NEMA VE 1.
- h. Connectors:
 - 1) Connector Hardware:
 - a) Provide 3/8-inch diameter truss head, ribbed neck steel screws having a Phillips recess and free spinning, lock type steel nuts which do not need a washer.
 - b) Protect the connector hardware finish against corrosion.
 - (1) Provide connector hardware either of steel that has been cadmium plated with a yellow chromate finish complying with the requirements specified for Class 5, Type II coatings in ASTM B 766, or Type 316 stainless steel.
 - 2) Connector Splices:



- a) Provide connector splices having an electrical resistance of less than 0.00033 ohms.
- 3) Expansion Connectors:
 - a) Provide expansion connectors capable of providing for tray expansion of at least 1 inch, and located as shown on the Contract Drawings or as required to prevent damage to the tray system from thermal expansion and contraction.
 - b) Install grounding bonding jumpers at all adjustable connectors and expansion connectors.
- i. Manufacturers:
 - 1) Cablofil/Legrand®, PW Industries, <http://www.pwindustries.com>.
 - 2) Approved equal.
- 3. Trough Cable Trays:
 - a. Provide fabricated metal structures greater than 4 inches in width, and consisting of integral or separate longitudinal side rails and a bottom having openings sufficient for the passage of air.
 - 1) For trough type cable trays indicated to receive a mill galvanized (PGSTL) coating on the Contract Drawings, apply the coating at the steel mill in accordance with the requirements specified in ASTM A 924/A 924M and ASTM A 653/A 653M.
 - 2) For trough type cable trays indicated to receive a hot dipped galvanized finish after fabrication (HDGAF) on the Contract Drawings, apply the coating in accordance with the requirements specified in ASTM A 123/A 123M.
 - 3) For trough type cable trays indicated to be aluminum (ALUM) on the Contract Drawings, construct the cable trays from copper free aluminum Alloy 6063-T6.
 - a) Construct fittings and accessories from a corrosion resistant aluminum alloy that is compatible with aluminum Alloy 6063, such as Alloy 5052 or Alloy 3003.
 - b. Lengths of Straight Sections:
 - 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - a) The manufacturer's standard lengths must include 12 feet and 20 feet, not including their connectors if they are attached.
 - 2) Provide straight section lengths that are greater than or equal to the support span length.
 - 3) Provide straight section lengths so that at most only one splice joint occurs between any 2 cable tray supports.
 - c. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard widths must include 6 inches, 9 inches, 12 inches, 18 inches, 24 inches, 30 inches, and 36 inches



- in compliance with the requirements specified in Section 4.3.3.1 of NEMA VE 1.
- d. Side Rail Height:
 - 1) Provide actual side rail heights as indicated on the Contract Drawings.
 - a) The manufacturer's standard side rail heights must include 4 inches, 5 inches, 6 inches, and 7 inches in compliance with the requirements specified in Section 4.3.4.3 of NEMA VE 1.
 - e. Transverse Elements:
 - 1) Provide trough cable tray having no more than 4 inches of open space between transverse elements in the direction parallel to the side rails.
 - f. Troughs:
 - 1) Rung Style Troughs:
 - a) Provide rung style troughs having the manufacturer's standard rung spacing.
 - (1) For aluminum trays, the manufacturer's standard rungs must include 4-inch wide channels, and the manufacturer's standard rung spacing must include rungs spaced 8 inches apart on center.
 - (2) For steel trays, the manufacturer's standard rungs must include 1-1/4-inch wide channels, and the manufacturer's standard rung spacing must include rungs spaced 5 inches apart on center.
 - (3) For fittings, provide space rungs spaced 5 inches apart on center.
 - b) Weld the rungs to the side rails.
 - 2) Ventilated, Corrugated Bottom Style Troughs:
 - a) Provide ventilated, corrugated bottom style troughs having the manufacturer's standard ventilated corrugated bottoms welded to the side rails.
 - (1) The manufacturer's standard ventilated, corrugated bottom style troughs must include 3/8-inch wide by 1-1/4-inch long ventilation slots spaced on 1-1/2-inch centers across the tray width, and spaced along the length of the tray 2.19 inches apart on center.
 - (2) Provide 0.5-inch high corrugated bottoms having 0.875-inch top cable supporting ribs spaced along the length of the tray 2.19 inches apart on center.
 - g. Tray Fittings:
 - 1) Provide the types and quantities of tray fittings indicated on the Contract Drawings.
 - 2) Fabricate cable tray fittings from the same material as the straight tray sections.



- 3) The manufacturer's standard fittings must include at a minimum the following types:
 - a) Horizontal elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles.
 - b) Vertical elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles with inside and outside radius options.
 - c) Horizontal adjustable elbow fittings having an adjustable angle.
 - d) Horizontal and vertical tee fittings having a branch at a 90-degree angle.
 - e) Horizontal wye fittings having a branch at a 45-degree angle.
 - f) Horizontal and vertical cross fittings having branches at 90-degree angles.
 - g) Horizontal Reducers:
 - (1) Straight Type:
 - (a) Reducer fitting having 2 symmetrical offsets from the centerline of the fitting.
 - (2) Right Hand Type:
 - (a) Reducer having a straight side on right side of the fitting when viewed from the large tray width side.
 - (3) Left Hand Type:
 - (a) Reducer having a straight side on left side of the fitting when viewed from the large tray width side.
- 4) Fitting Radius:
 - a) Provide fittings having a nominal bend radius of 12 inches measured on the smallest side as indicated on the Contract Drawings.
 - b) Provide fittings having a bend radius appropriate for the allowable bending radius of the cables to be installed in the fitting.
 - c) The manufacturer's standard fitting radii must comply with the specified working (allowable) load capacity requirements.
- h. Connectors:
 - 1) Connector Hardware:
 - a) Provide 3/8-inch diameter truss head, ribbed neck steel screws having a Phillips recess and free spinning, lock type steel nuts which do not need a washer.
 - b) Protect the connector hardware finish against corrosion.
 - (1) Provide connector hardware either of steel that has been cadmium plated with a yellow chromate finish complying with the requirements specified for Class 5, Type II coatings in ASTM B 766, or Type 316 stainless steel.
 - 2) Connector Splices:
 - a) Provide connector splices having an electrical resistance of less than 0.00033 ohms.



- 3) Expansion Connectors:
 - a) Provide expansion connectors capable of providing for tray expansion of at least 1 inch, and located as shown on the Contract Drawings or as required to prevent damage to the tray system from thermal expansion and contraction.
 - b) Install grounding bonding jumpers at all adjustable connectors and expansion connectors.
- i. Manufacturers:
 - 1) Cablofil/Legrand®, PW Industries, <http://www.pwindustries.com>.
 - a) Mill galvanized steel: PW Industries 05-2C31.
 - b) Hot dipped galvanized after fabrication steel: PW Industries 05-1C31.
 - 2) Approved equal.
4. Corrugated Solid Bottom Cable Trays:
 - a. Provide prefabricated metal cable tray structures consisting of a solid corrugated bottom having no openings and 2 integral or separate longitudinal side rails.
 - 1) Provide corrugated solid bottoms having no more than 1-5/16 inch space between corrugations.
 - 2) For corrugated solid bottom type cable trays indicated to receive a mill galvanized (PGSTL) coating on the Contract Drawings, apply the coating at the steel mill in accordance with the requirements specified in ASTM A 924/A 924M and ASTM A 653/A 653M.
 - 3) For corrugated solid bottom type cable trays indicated to receive a hot dipped galvanized finish after fabrication (HDGAF) on the Contract Drawings, apply the coating in accordance with the requirements specified in ASTM A 123/A 123M.
 - 4) For corrugated solid bottom type cable trays indicated to be aluminum (ALUM) on the Contract Drawings, construct the cable trays from copper free aluminum Alloy 6063-T6.
 - a) Construct fittings and accessories from a corrosion resistant aluminum alloy that is compatible with aluminum Alloy 6063, such as Alloy 5052 or Alloy 3003.
 - b. Length of Straight Sections:
 - 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - a) The manufacturer's standard lengths must include 12 feet and 20 feet, not including their connectors if they are attached.
 - 2) Provide straight section lengths that are greater than or equal to the support span length.
 - 3) Provide straight section lengths so that at most only one splice joint occurs between any 2 cable tray supports.
 - c. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.



- 2) The manufacturer's standard ladder tray selections must include full width and half width bottom rung configurations.
 - a) The manufacturer's standard widths must include 6 inches, 9 inches, 12 inches, 18 inches, 24 inches, 30 inches, and 36 inches in compliance with the requirements specified in Section 4.3.3.1 of NEMA VE 1.
- d. Side Rail Height:
 - 1) Provide actual side rail heights as indicated on the Contract Drawings.
 - a) The manufacturer's standard side rail heights must include 4 inches, 5 inches, 6 inches, and 7 inches in compliance with the requirements specified in Section 4.3.4.3 of NEMA VE 1.
- e. Side Channels:
 - 1) Provide side channel members configured as 'C' channels having a top flange measuring at least 1-inch.
- f. Tray Bottoms:
 - 1) Provide corrugated solid bottom cable trays having the manufacturer's standard solid corrugated bottoms welded to the side rails.
 - a) Provide 0.5-inch high corrugated bottoms having 0.875-inch top cable supporting ribs spaced along the length of the tray 2.19 inches apart on center.
- g. Tray Fittings:
 - 1) Provide the types and quantities of tray fittings indicated on the Contract Drawings.
 - 2) Fabricate cable tray fittings from the same material as the straight tray sections.
 - 3) The manufacturer's standard fittings must include at a minimum the following types:
 - a) Horizontal elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles.
 - b) Vertical elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles with inside and outside radius options.
 - c) Horizontal adjustable elbow fittings having an adjustable angle.
 - d) Horizontal and vertical tee fittings having a branch at a 90-degree angle.
 - e) Horizontal wye fittings having a branch at a 45-degree angle.
 - f) Horizontal and vertical cross fittings having branches at 90-degree angles.
 - g) Horizontal Reducers:
 - (1) Straight Type:
 - (a) Reducer fitting having 2 symmetrical offsets from the centerline of the fitting.
 - (2) Right Hand Type:



- (a) Reducer having a straight side on right side of the fitting when viewed from the large tray width side.
 - (3) Left Hand Type:
 - (a) Reducer having a straight side on left side of the fitting when viewed from the large tray width side.
 - 4) Fitting Radii:
 - a) Provide fittings having a nominal bend radius of 12 inches measured on the smallest side as indicated on the Contract Drawings.
 - b) Provide fittings having a bend radius appropriate for the allowable bending radius of the cables to be installed in the fitting.
 - c) The manufacturer's standard fitting radii must include 12-inch, 24-inch, 36-inch, and 48-inch radii in accordance with the requirements specified in NEMA VE 1.
 - h. Connectors:
 - 1) Connector Hardware:
 - a) Provide 3/8-inch diameter truss head, ribbed neck steel screws having a Phillips recess and free spinning, lock type steel nuts which do not need a washer.
 - b) Protect the connector hardware finish against corrosion.
 - (1) Provide connector hardware either of steel that has been cadmium plated with a yellow chromate finish complying with the requirements specified for Class 5, Type II coatings in ASTM B 766, or Type 316 stainless steel.
 - 2) Connector Splices:
 - a) Provide connector splices having an electrical resistance of less than 0.00033 ohms.
 - 3) Expansion Connectors:
 - a) Provide expansion connectors capable of providing for tray expansion of at least 1 inch, and located as shown on the Contract Drawings or as required to prevent damage to the tray system from thermal expansion and contraction.
 - b) Install grounding bonding jumpers at all adjustable connectors and expansion connectors.
 - i. Manufacturers:
 - 1) Cablofil/Legrand®, PW Industries, <http://www.pwindustries.com>.
 - a) Mill galvanized steel: PW Industries B360.
 - b) Hot dipped galvanized after fabrication steel: PW Industries A360.
 - c) Aluminum: PW Industries 5720.
 - 2) Approved equal.
- 5. Channel Cable Trays:



- a. Provide prefabricated metal cable tray structures consisting of a one piece ventilated bottom or solid bottom channel section, or both, not exceeding 6 inches in width.
 - 1) For channel cable trays indicated to receive a mill galvanized (PGSTL) coating on the Contract Drawings, apply the coating at the steel mill in accordance with the requirements specified in ASTM A 924/A 924M and ASTM A 653/A 653M.
 - 2) For channel cable trays indicated to receive a hot dipped galvanized finish after fabrication (HDGAF) on the Contract Drawings, apply the coating in accordance with the requirements specified in ASTM A 123/A 123M.
 - 3) For channel cable trays indicated to be aluminum (ALUM) on the Contract Drawings, construct the cable trays from copper free aluminum Alloy 6063-T6.
 - a) Construct fittings and accessories from a corrosion resistant aluminum alloy that is compatible with aluminum Alloy 6063, such as Alloy 5052 or Alloy 3003.
- b. Lengths of Straight Sections:
 - 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - a) The manufacturer's standard lengths of must include 12 feet, not including their connectors if they are attached.
- c. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard widths must include 3 inches, 4 inches, and 6 inches.
- d. Outside Depths:
 - 1) Provide actual cable tray outside depths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard outside depths must include 1-3/4 inches.
- e. Channel Fittings:
 - 1) Provide the types and quantities of channel fittings indicated on the Contract Drawings.
 - a) Fittings for tangent sections of channel fittings must be at least 2 inches.
 - 2) Fabricate cable tray fittings from the same material as the straight tray sections.
 - 3) The manufacturer's standard fittings must include at a minimum the following types:
 - a) Horizontal elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles.
 - b) Vertical elbow fittings for 30-degree, 45-degree, 60-degree, and 90-degree angles with inside and outside radius options.



- c) Horizontal tee fittings having a branch at a 90-degree angle.
 - d) Horizontal cross fittings having branches at 90-degree angles.
 - f. Fitting Radii:
 - 1) Fitting Radii:
 - a) Provide fittings having a nominal bend radius of 12 inches measured on the smallest side as indicated on the Contract Drawings.
 - b) The manufacturer's standard fitting radii must include 12-inch, 24-inch, and 36-inch radii in accordance with the requirements specified in NEMA VE 1.
 - g. Connectors:
 - 1) Connector Hardware:
 - a) Provide 3/8-inch diameter truss head, ribbed neck steel screws having a Phillips recess and free spinning, lock type steel nuts which do not need a washer.
 - b) Protect the connector hardware finish against corrosion.
 - (1) Provide connector hardware either of steel that has been cadmium plated with a yellow chromate finish complying with the requirements specified for Class 5, Type II coatings in ASTM B 766, or Type 316 stainless steel.
 - 2) Expansion Connectors:
 - a) Provide expansion connectors capable of providing for tray expansion of at least 1 inch, and located as shown on the Contract Drawings or as required to prevent damage to the tray system from thermal expansion and contraction.
 - b) Install grounding bonding jumpers at all adjustable connectors and expansion connectors.
 - h. Manufacturers:
 - 1) Cablofil/Legrand®, PW Industries, <http://www.pwindustries.com>.
 - a) Mill galvanized steel: PW Industries 2508-03.
 - b) Hot dipped galvanized after fabrication steel: PW Industries 1508-03.
 - c) Aluminum: PW Industries 5508-03.
 - 2) Approved equal.
- 6. Wire Basket Cable Support Systems:
 - a. Provide wire basket cable support systems for communications cabling consisting of high strength steel wires formed into a standard 2-inch by-4 inch wire mesh pattern having the intersecting wires welded together.
 - 1) For carbon steel wire mesh sections, provide wire having a diameter of at least 0.196 inch (5mm).
 - 2) For stainless steel wire mesh sections, provide wire having a diameter of at least 4.5mm.
 - b. Straight Sections:



- 1) For all tray sizes, provide wire basket straight sections having a continuous longitudinal top wire safety edge that is kinked and T-welded.
- 2) Provide wire basket straight sections having at least one longitudinal bottom wire along entire length of the section.
- c. Lengths of Straight Sections:
 - 1) Provide actual cable tray lengths and quantities as indicated on the Contract Drawings.
 - 2) The manufacturer's standard straight lengths of must include 118-inch long sections, not including their connectors if they are attached.
- d. Depths:
 - 1) Provide actual cable tray depths as indicated on the Contract Drawings.
 - a) The manufacturer's standard usable wire basket cable support loading depths must include 1 inch, 2 inches, 4 inches, and 6 inches.
- e. Tray Widths:
 - 1) Provide actual cable tray widths as indicated on the Contract Drawings.
 - 2) The manufacturer's standard usable widths associated with loading depths indicated must include the following:
 - a) The manufacturer's standard widths for wire basket cable supports having a 1-inch usable loading depths must include 4 inches, 6 inches, 8 inches, and 12 inches.
 - b) The manufacturer's standard widths for wire basket cable supports having a 2-inch usable loading depths must include 2 inches, 4 inches, 6 inches, 8 inches, 12 inches, 16 inches, 18 inches, 20 inches, 24 inches, 30 inches, and 32 inches.
 - c) The manufacturer's standard widths for wire basket cable supports having a 4-inch usable loading depths must include 4 inches, 6 inches, 8 inches, 12 inches, 16 inches, 18 inches, 20 inches, 24 inches, and 30 inches.
 - d) The manufacturer's standard widths for wire basket cable supports having a 6-inch usable loading depths must include 8 inches, 12 inches, 16 inches, 18 inches, 20 inches, and 24 inches.
- f. Tray Fittings:
 - 1) Provide the types and quantities of tray fittings indicated on the Contract Drawings.
 - 2) Field-form fittings from straight sections in accordance with the manufacturer's instructions.
 - a) Submit the wire basket cable support system manufacturer's instructions for field-forming fittings to the Program/Project Manager for information.



- 3) Fitting Radius:
 - a) Provide fittings having a bend radius appropriate for the allowable bending radius of the cables to be installed in the fitting.
- g. Manufacturers:
 - 1) Cooper B-Line, Inc., <http://www.b-line.com>.
 - 2) Cablofil/Legrand®, PW Industries, <http://www.cablofil.com>.
 - 3) Approved equal.

A. Fabrication:

- 1. Fabricate the cable trays to have rounded edges and smooth surfaces in compliance with the applicable standards specified.

2.02 ACCESSORIES

A. Covers:

- 1. Provide cable trays having tray covers where indicated on the Contract Drawings.
 - a. The manufacturers standard tray covers must include flat covers with no side flanges, flat covers with side flanges, louvered flat covers with no side flanges, louvered flat covers with side flanges, and 15 degree peaked covers with side flanges.
 - b. The manufacturers standard tray covers for fittings must be available with the same configuration as covers for straight trays.
- 2. Provide covers for the trays fabricated from the same material as the straight trays and fittings at exterior locations, or as indicated on the Contract Drawings.
- 3. Provide the standard manufacturer's hardware required to hold the covers to the cable tray sections.
 - a. Provide "Clip Type" clamps on indoor, horizontal cable trays.
 - b. Provide heavy duty "Strap Type" clamps on outdoor and vertical cable tray sections.

B. Divider Strips:

- 1. Provide divider strips where indicated on the Contract Drawings.
- 2. Attach divider strips to the cable tray rungs in the field using standard manufacturer-supplied hardware.
- 3. Provide divider strips fabricated from the same material as the straight tray and fittings, or as indicated on the Contract Drawings.

C. Blind End Plates:

- 1. Provide blind end plates where indicated on the Contract Drawings.
- 2. Provide blind end plates fabricated from the same material as the straight tray and fitting, or as indicated on the Contract Drawings.

D. Cable Dropouts:



1. Provide cable dropouts where indicated on the Contract Drawings.
 2. Provide cable dropouts fabricated from the same material as the straight tray and fitting, or as indicated on the Contract Drawings.
- E. Wall Penetration Sleeves:
1. For the wall penetrations indicated on the Contract Drawings, provide wall penetration sleeves designed for a single run of cable tray having a standard overall tray width and depth, and complying with the requirements specified in Section 16050, Basic Electrical Materials and Methods.
 - a. Hot dip galvanize the wall penetration sleeves' steel, after fabrication in accordance with the requirements specified in ASTM A 123/A 123M.
- F. Firestopping System:
1. Provide through-penetration firestopping materials complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems, for the Underwriters Laboratories, Inc. (UL) XHEZ Category Code, or fire-resistive joint systems complying with the requirements specified in Section 07842, Fire-Resistive Joint Systems, for the Underwriters Laboratories, Inc. (UL) XHBN Category Code.
- G. Conduit and Pipe Clamps:
1. Provide standard manufacturer-designed conduit and pipe clamps and/or brackets as required by code to clamp conduit and pipe.
- H. Hangers and Supports:
1. Provide hangers and supports as specified in Section 16070, Hangers and Supports.
 - a. Provide center support hangers, trapeze hangers, or wall brackets as recommended by the cable tray manufacturer.
 - b. Support trapeze hangers or center support hangers using 3/8 inch diameter rods as specified.
- I. Wire Basket Support System Accessories:
1. Provide special accessories required to protect, support, and install the wire basket support systems.

2.03 SOURCE QUALITY CONTROL

- A. Manufacturer Services:
1. Have the manufacturer test the cable trays under the "worst case" loading conditions outlined in this Specification in accordance with the requirements specified in NEMA VE 1, have these tests witnessed by an independent testing laboratory, and prepare test reports documenting the results of the tests.



2. Submit the manufacturer's test reports to the Program/Project Manager for information.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Field-verify the dimensions, routing, and other information related to the cable tray systems indicated on the Contract Drawings.
 2. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
 - a. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the cable tray systems.
- B. Surface Preparation:
 1. Provide cable tray supports at the locations shown in NEMA VE 2, and space the supports no more than 10 feet apart.
 - a. Install auxiliary support structures, anchors, and fasteners as specified in Section 16070, Hangers and Supports.
- C. Demolition/Removal:
 1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

- A. Install the cable trays at the locations indicated in the Contract Drawings, in accordance with the cable tray manufacturer's installation instructions, and in accordance with the requirements specified for installing cable tray systems in NFPA 70, NFPA 70B, NECA 1, and ANSI/NECA/NEMA 105.
 1. Do not install damaged equipment.
 2. Install metallic cable tray in accordance with the additional requirements specified in NEMA VE 1 and NEMA VE 2.
 3. Provide expansion connectors where required.
 4. Submit the cable tray manufacturer's preparation and installation instructions, including application conditions and limitations of use stipulated by the product testing agency, to the Program/Project Manager for information.



B. Elevation:

1. Install straight cable tray sections, fittings, and accessories at the height from the floor to the bottom of the cable tray indicated on the Contract Drawings.

C. Special Techniques:

1. Grounding:

- a. Provide a continuous ground from section to section and from the cable tray to the building ground in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding, or Section 16062, Communications Grounding and Bonding, as applicable.
- b. Provide cable tray systems capable of being used as an equipment grounding conductor in accordance with the requirements specified in Article 392-7(b) of NFPA 70.
 - 1) When using powder coated wire basket cable trays as an equipment ground conductor (EGC), the powder coat paint must be completely removed at all contact points of the splice/ground bolt attachment.
- c. Mark the cable tray sections and fittings to show the minimum cross sectional area in accordance with the requirements specified in Article 392-7 of NFPA 70.
- d. Construct bonding jumpers from laminated aluminum or insulated copper wire with a minimum ampere rating in accordance with the requirements specified in Article 250-95 of NFPA 70 as follows, or as indicated on the Contract Drawings:
 - 1) Center Hung Type Cable Tray: 1000 rated amperes.
 - 2) Ladder Type Cable Tray: 200 rated amperes.
 - 3) Trough Type Cable Tray: 200 rated amperes.
 - 4) Corrugated Solid Bottom Type Cable Tray: 200 rated amperes.

D. Interface with Other Work:

1. Fire-Rated Wall Penetrations:

- a. For wall penetration sleeves in fire rated locations, provide a sufficient firestopping system to furnish a 2-hour fire rated wall.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Bonding and Grounding Continuity Test:

a. Test Procedure:

- 1) Test wire basket support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance.
- 2) Perform the testing in accordance with the test methods specified in Chapter 21 of NFPA 70B.



- b. Acceptance Criteria:
 - 1) Cable trays represented by test results complying with the requirements specified in Section 16062, Communications Grounding and Bonding, for the maximum grounding resistance pass the Bonding and Grounding Continuity Test.
 - a) Circuits displaying electrical discontinuities fail the Bonding and Grounding Continuity Test.
 - 2. Inspections:
 - a. As-Built Documents:
 - 1) Prepare as-built drawings recording the actual routing of the cable trays and the locations of supports, and submit them to the Program/Project Manager for information.
- B. Non-Conforming Work
 - 1. Cable trays will be considered defective if they do not pass the specified inspections and tests.
 - 2. Where possible, correct malfunctioning units onsite, and retest the corrected units to demonstrate compliance with the specified requirements; otherwise, replace malfunctioning units with new units and retest the replacement units.

3.05 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.06 PROTECTION

- A. Take steps to ensure that installed cable trays are protected during subsequent construction activities.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of wiring devices:
 - a. Receptacles, receptacles with integral GFCI, and associated device plates.
 - b. Twist-locking receptacles.
 - c. Wall-box motion sensors.
 - d. Isolated-ground receptacles.
 - e. Snap switches.
 - f. Wall-switch and exterior occupancy sensors.
 - g. Communications outlets.
 - h. Pendant cord-connector devices.
 - i. Cord and plug sets.
 - j. Floor service outlets, and multi-outlet assemblies.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16075 – Electrical Identification.
 - 4. Section 16080 - Electrical Testing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. GFCI: Ground-fault circuit interrupter.
 - 2. LED: Light emitting diode.
 - 3. PVC: Polyvinyl chloride.
 - 4. TVSS: Transient voltage surge suppressor.
 - 5. UTP: Unshielded twisted pair.
- B. Definitions:
 - 1. Pigtail: A short lead used to connect a device to a branch-circuit conductor.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 602 - IEEE Recommended Practice for Electric Systems in Health Care Facilities.



3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
5. National Electrical Manufacturers Association (NEMA):
 - a. NEMA WD 1 - General Color Requirements for Wiring Devices.
 - b. ANSI/NEMA WD 6 - Wiring Devices—Dimensional Requirements.
6. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
7. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practices for Good Workmanship in Electrical Construction
8. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
9. Underwriters Laboratories, Inc. (UL):
 - a. UL 20 - Standard for Safety for General-Use Snap Switches.
 - b. UL 498 - Standard for Attachment Plugs and Receptacles.
 - c. UL 943 - Standard for Safety for Ground-Fault Circuit-Interrupters.
 - d. UL 1436 - Standard for Outlet Circuit Testers and Similar Indicating Devices.
 - e. UL 1863 - Standard for Communications-Circuit Accessories.
 - f. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 2. Coordinate the required supporting wiring, raceway, and box sizes with the wiring devices.
 3. Receptacles for Owner-Furnished Equipment:
 - a. Coordinate with the Program/Project Manager to provide receptacles that match the plug configurations of Owner-furnished equipment.
 - b. Cord and Plug Sets:
 - 1) Coordinate equipment requirements so the cord and plug sets match the receptacles.



B. Sequencing:

1. Install the required supporting raceway and boxes prior to the scheduled installation of the wiring devices.
2. Install wiring devices after all wall preparation, including painting, is complete.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Convenience receptacles.
- 2) Hospital-grade, duplex convenience receptacles.
- 3) Duplex ground-fault circuit interrupter (GFCI) receptacles.
- 4) Isolated-ground, duplex convenience receptacles.
- 5) Twist-locking receptacles.
- 6) Pendant cord-connector devices.
- 7) Cord and plug sets.
- 8) General-use snap switches.
- 9) Pilot light switches.
- 10) Key-operated switches.
- 11) Single-pole, double-throw, momentary contact, center-off switches.
- 12) Wall-switch sensors.
- 13) Long-range wall-switch sensors.
- 14) Telephone outlet.
- 15) Wall plates.
- 16) Wet-location, weatherproof cover plates.
- 17) Power receptacle floor service fittings.
- 18) Voice and data communication outlet floor service fittings.
- 19) Multioutlet assemblies.

b. Shop Drawings:

- 1) List of legends.
- 2) Materials and process to be used for pre-marking wall plates.

c. Qualification Statements:

- 1) Testing Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Site Quality Control Submittals:

- 1) Field quality-control test reports.



- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Wiring devices.
- D. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Floor Service Outlet Assemblies:
 - (1) Furnish a number of floor service outlet assemblies equal 1 for every 10 installed, but no fewer than 1.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
 - 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Testing Agency's Qualifications:
 - a. Employ a Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL), that is acceptable to the Authorities Having



Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.

- 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET).
- 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.



2. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain each type of wiring device and associated wall plate from a single source from single manufacturer.
 - 2) Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Description:

1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with requirements specified for wiring devices in NFPA 70.

C. Design Criteria:

1. Color:
 - a. The catalog numbers of wiring device given in this Section do not designate device color.
 - b. For wiring devices connected to normal power system, provide grey colored devices for the public spaces and ivory colored devices for the non-public spaces unless otherwise indicated or required by NFPA 70 or the device listing.
 - c. For wiring devices connected to an emergency power system, provide red colored devices.
 - d. For transient voltage surge suppressor (TVSS) devices, provide blue colored devices.
 - e. For isolated-ground receptacles, provide orange colored receptacles.
2. Cover Plates



- a. Shall be stainless steel unless otherwise noted.
 - b. Shall be provided with permanent, typed label including branch circuit number. Provide white label with black lettering for normal power and red lettering for emergency power.
 - 3. Product Data:
 - a. For each type of wiring device indicated, submit Product Data to the Program/Project Manager for approval.
 - 4. Shop Drawings:
 - a. Submit Shop Drawings that include a list of legends, and a description of the materials and process to be used for pre-marking wall plates to the Program/Project Manager for approval.
- D. Materials:
 - 1. Straight Blade Receptacles:
 - a. Convenience Receptacles:
 - 1) Provide 125 Volt, 20 Ampere convenience receptacles complying with the requirements specified in NEMA WD 1 and UL 498, and with the requirements for configuration 5-20R specified in NEMA WD 6.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 5351 (single), 5352 (duplex); www.cooperwiringdevices.com.
 - b) Hubbell Incorporated, Wiring Device-Kellems; HBL5351 (single), CR5352 (duplex); www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; 5891 (single), 5352 (duplex); www.leviton.com.
 - d) Pass & Seymour/Legrand; 5351 Series (single), 5352 Series (duplex); www.passandseymour.com.
 - e) Approved equal.
 - 2. Ground-Fault Circuit Interrupter (GFCI) Receptacles:
 - a. Provide straight blade, feed-through type ground-fault circuit interrupter (GFCI) receptacles complying with the requirements specified in NEMA WD 1, NEMA WD 6, and UL 498; and with the requirements for Class A receptacles specified in UL 943.
 - b. Provide ground-fault circuit interrupter (GFCI) receptacles that include an indicator light that lights up when the device is tripped by a ground fault.
 - c. Duplex Ground-Fault Circuit Interrupter (GFCI) Convenience Receptacles:
 - 1) Provide 125 Volt, 20 Ampere feed-through type duplex GFCI convenience receptacles.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; GF20 Series; www.cooperwiringdevices.com.
 - b) Pass & Seymour/Legrand; 2084; www.passandseymour.com.



- c) Approved equal.
- d. Isolated-Ground, Duplex Convenience Receptacles:
 - 1) Provide straight blade, 125 Volt, 20 Ampere isolated-ground, duplex convenience receptacles complying with the requirements for configuration 5-20R specified in NEMA WD 6.
 - a) For equipment grounding contacts, provide a green grounding screw terminal on the device inherently isolated electrically from the mounting strap.
 - b) Provide receptacles with isolation integral to the receptacle construction, and not dependent on removable parts.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; IG5362BLS; www.cooperwiringdevices.com.
 - b) Hubbell Incorporated Wiring Device-Kellems; IG5362SA; www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; 5380-IG; www.leviton.com.
 - d) Approved equal.
- 3. Twist-Locking Receptacles:
 - a. Provide single, 125 Volt, 20 Ampere twist-locking convenience receptacles complying with the requirements specified in NEMA WD 1 and UL 498, and with the requirements for configuration 5-20R specified in NEMA WD 6.
 - b. Manufacturers:
 - 1) Cooper Wiring Devices, a division of Cooper Industries, Inc.; L520R Series; www.cooperwiringdevices.com.
 - 2) Hubbell Incorporated Wiring Device-Kellems; HBL2310; www.hubbell-wiring.com.
 - 3) Leviton Manufacturing Company, Inc.; 2310; www.leviton.com.
 - 4) Pass & Seymour/Legrand; L520-R; www.passandseymour.com.
 - 5) Approved equal.
- 4. Pendant Cord-Connector Devices:
 - a. Provide heavy-duty grade pendant cord-connector devices having a matching, locking-type plug and receptacle body; and complying with the requirements for configurations L5-20P and L5-20R specified in NEMA WD 6.
 - 1) Body:
 - a) Provide nylon devices having screw-open cable-gripping jaws and a provision for attaching an external cable grip.
 - 2) External Cable Grip:
 - a) Provide an external type woven wire-mesh cable grip made of high-strength galvanized-steel wire strand, matched to the cable diameter, and having an attachment provision designed for the corresponding connector.
- 5. Cord and Plug Sets:



- a. Provide cord and plug sets that match the voltage and current ratings and the number of conductors to the requirements of the equipment being connected.
 - 1) Cord:
 - a) Provide rubber-insulated cords having stranded-copper conductors with Type SOW-A jacket, a green-insulated grounding conductor, and having ampacity equal to the equipment-rating ampacity plus a minimum of 30 percent.
 - 2) Plug:
 - a) Provide plugs having a nylon body and integral cable-clamping jaws.
 - b) Match the cord and receptacle type to the connection.
6. Snap Switches:
 - a. General-Use Snap Switches:
 - 1) Provide 120/277 Volt, 20 Ampere snap switches complying with the requirements specified in NEMA WD 1 and UL 20.
 - 2) Manufacturers:
 - 1) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way); www.cooperwiringdevices.com.
 - 2) Hubbell Incorporated Wiring Device-Kellems; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way); www.hubbell-wiring.com.
 - 3) Leviton Manufacturing Company, Inc.; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way); www.leviton.com.
 - 4) Pass & Seymour; 20AC1 Series (single pole), PS20AC2 Series (two pole), 20AC3 Series (three way), 20AC4 Series (four way); www.passandseymour.com.
 - 5) Approved equal.
 - b. Pilot Light Switches:
 - 1) Provide 120/277 Volt, 20 Ampere snap switches complying with the requirements specified in NEMA WD 1 and UL 20.
 - 2) Provide single pole pilot light switches having a neon-lighted handle that is illuminated when the switch is in the "ON" position.
 - 3) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 2221PL for 120 V and 277 V; www.cooperwiringdevices.com.
 - b) Hubbell Incorporated Wiring Device-Kellems; HBL1221PL for 120 V and 277 V; www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; 1221-PLR for 120 V, 1221-7PLR for 277 V; www.leviton.com.
 - d) Pass & Seymour; PS20AC1RPL for 120 V; www.passandseymour.com.
 - e) Approved equal.
 - c. Key-Operated Switches:



- 1) Provide 120/277 Volt, 20 Ampere snap switches complying with the requirements specified in NEMA WD 1 and UL 20.
- 2) Provide single pole key-operated switches having a factory-supplied key in lieu of a switch handle.
- 3) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 2221L; www.cooperwiringdevices.com.
 - b) Hubbell Incorporated Wiring Device-Kellems; HBL1221L; www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; 1221-2L; www.leviton.com.
 - d) Pass & Seymour; PS20AC1KL; www.passandseymour.com.
 - e) Approved equal.
- d. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches:
 - 1) Provide single pole, double throw 120/277 Volt, 20 Ampere momentary contact, center-off switches suitable for use with mechanically held lighting contactors.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 1995; www.cooperwiringdevices.com.
 - b) Hubbell Incorporated Wiring Device-Kellems; HBL1557; www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; 1257; www.leviton.com.
 - d) Pass & Seymour; 1251 Series; www.passandseymour.com.
 - e) Approved equal.
7. Occupancy Sensors:
 - a. Wall-Switch Sensors:
 - 1) Provide 120/277 Volt, passive-infrared type wall-switch sensors having an adjustable time delay of up to 30 minutes, a 180-degree field of view, and a minimum coverage area of 900 square feet.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 6111 for 120 V, 6117 for 277 V; www.cooperwiringdevices.com.
 - b) Hubbell Incorporated Wiring Device-Kellems; WS1277Series www.hubbell-wiring.com.
 - c) Leviton Manufacturing Company, Inc.; ODS 10-ID Series; www.leviton.com.
 - d) Pass & Seymour; WSP200; www.passandseymour.com.
 - e) Watt Stopper; WS-200, <http://www.wattstopper.com>.
 - f) Approved equal.
 - b. Long-Range Wall-Switch Sensors:
 - 1) Provide 120/277 Volt, dual technology long-range wall-switch sensors with both passive-infrared- and ultrasonic-type sensing and having an adjustable time delay of up to 30 minutes, a 110-



- degree field of view, and a minimum coverage area of 1200 square feet.
- 2) Manufacturers:
 - a) Hubbell Incorporated Wiring Device-Kellems; ATD1600WRP; www.hubbell-wiring.com.
 - b) Leviton Manufacturing Company, Inc.; ODW12-MRW; www.leviton.com.
 - c) Watt Stopper; DT-200 Series, <http://www.wattstopper.com>.
 - d) Approved equal.
 8. Communications Outlets:
 - a. Telephone Outlet:
 - 1) Provide single RJ-45 jack telephone outlets capable of terminating 100-ohm, balanced, four-pair unshielded twisted pairs (UTP) complying with the requirements for Category 5e cable specified in ANSI/TIA/EIA-568-B.1, and complying with the requirements specified in UL 1863.
 - 2) Manufacturers:
 - a) Cooper Wiring Devices, a division of Cooper Industries, Inc.; 3560-4; www.cooperwiringdevices.com.
 - b) Leviton Manufacturing Company, Inc.; 40649; www.leviton.com.
 - c) Approved equal.
 - a. Wall Plates:
 - a. Provide single and combination types of wall plates to match the corresponding wiring devices.
 - 1) Plate-Securing Screws:
 - a) Provide metal screws having a head color to match the plate finish for securing the wall plates.
 - 2) Material for Finished Spaces:
 - a) Provide 0.035 –inch thick, satin-finished stainless steel wall plates for finished spaces.
 - 3) Material for Unfinished Spaces:
 - a) Provide galvanized steel wall plates for unfinished spaces.
 - 4) Material for Damp Locations:
 - a) Provide cast aluminum wall plates having a spring-loaded lift cover, and listed and labeled by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for use in "wet locations".
 - b. Wet-Location, Weatherproof Cover Plates:
 - 1) Provide die-cast aluminum wall plates complying with the requirements for NEMA type 3R enclosures specified in NEMA 250b while in use weather-resistant, and having a lockable cover.
 10. Floor Service Fittings:



- a. Provide floor service fittings having a rectangular solid brass service plate having a satin finish, and designed for the appropriate service, whether power receptacles or voice and data communications outlets.
 - 1) Provide modular, flush-type, dual-service units suitable for the wiring method used.
 - b. Compartments:
 - 1) Provide a barrier to separate power from voice and data communication cabling.
 - c. Power Receptacle:
 - 1) Provide power receptacle floor service fittings complying with the requirements for configuration 5-20R specified in NEMA WD 6.
 - 2) Unless otherwise indicated, provide units with a gray finish.
 - d. Voice and Data Communication Outlet:
 - 1) Provide voice and data communication outlet floor service fittings having 2 modular, keyed, color-coded, RJ-45 jacks suitable for Category 5e unshielded twisted pair (UTP) cable.
11. Multioutlet Assemblies:
- a. Components of Assemblies:
 - 1) Provide products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 - b. Raceway Material:
 - 1) Provide polyvinyl chloride (PVC) raceway.
 - c. Wire:
 - 1) Provide 12AWG wire.
 - d. Manufacturers:
 - 1) Hubbell Incorporated Wiring Device-Kellems; www.hubbell-wiring.com.
 - 2) Wiremold /Legrand, www.wiremold.com.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the locations to receive wiring devices are ready for the Work of this Section.
 - a. Examine the locations to receive the wiring devices.
 - b. Although the Contract Drawings are generally indicative of the Work, field-verify the actual conditions.
 - 1) Due to the small scale of the Contract Drawings it is not possible to indicate minor structural obstructions or relocations that may be encountered during the Work.
 - 2. Verify that electrical boxes and enclosures to be mated with the wiring devices are the correct type and size, and are at the proper location.
- B. Evaluation and Assessment:



1. Only begin the Work of this Section after the verification of conditions and the correction of non-conformances affecting the wiring devices have been completed.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the wiring devices.
- B. Surface Preparation:
 1. For device boxes installed in brick or block walls, do not allow the cover plate to cross a joint unless the joint has been troweled flush with the face of the wall.
- C. Demolition/Removal:
 1. Do not cut holes for boxes with routers that are guided by riding against the outside of the boxes.

3.03 INSTALLATION

- A. Install the wiring devices in accordance with the requirements specified in NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Arrangement of Devices:
 1. Unless otherwise indicated, mount wiring devices flush, with the long dimension vertical and with the grounding terminal of receptacles on top.
 2. Group adjacent switches under single, multigang wall plates.
 3. Receptacle Orientation:
 - a. Install the ground pin of vertically mounted receptacles down, and of horizontally mounted receptacles to the right.
- C. Device Installation:
 1. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 2. When there is a choice, use side wiring with binding-head screw terminals.
 - a. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around the terminal screw.
 3. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 4. When conductors larger than 12AWG are installed on 15- or 20-Amp circuits, splice 12AWG pigtails for the device connections.
 5. Tighten unused terminal screws on the device.
 6. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.



D. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose.
 - a. Avoid scoring or nicking the solid wire, or cutting strands from stranded wire.
3. Provide free conductors at outlets for devices of the length complying with the requirements specified in Article 300 of NFPA 70, without pigtails.
4. Only connect equipment grounding contacts to the green grounding screw terminal of the device.

E. Device Plates:

1. In accordance with the requirements specified in IEEE 602, do not use oversized or extra-deep plates.

F. Special Techniques:

1. Identification:
 - a. Identify wiring devices in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Receptacles:
 - a) Identify the panelboard and circuit number from which the receptacle is served.
 - 2) Provide hot, stamped or engraved machine printing with black-filled lettering on the face of the plate, and durable wire markers or tags inside outlet boxes.

G. Interface with Other Work:

1. When standard device plates do not fit flush or do not cover the rough wall opening, have the wall finishes repaired, and remount the outlet boxes.

3.04 REPAIR/RESTORATION

- A. Replace devices that have been in temporary use during construction, or that show signs that they were installed before building finishing operations were complete.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when wiring devices are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing



personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.

- 1) Periodic Special Inspections will be performed during the installation of seismic controls.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Wiring Device Testing:
- a. Test Procedure:
 - 1) Comply with the requirements specified in Section 16080, Electrical Testing.
 - 2) Test Instruments:
 - a) Furnish test instruments that comply with the requirements specified in UL 1436 for performing the testing.
 - b) Instruments for Testing Convenience Receptacles:
 - (1) Furnish digital wiring analyzers having either digital readout or illuminated LED measurement indicators.
 - 3) Perform diagnostic tests to find damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, and similar problems.
 - a) Determine the line voltage.
 - b) Determine the percent voltage drop under 15 Ampere load.
 - c) Determine the ground impedance.
 - d) Determine the GFCI tripping values.
 - 4) Prepare field quality-control test reports to document the test results, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Line Voltage:
 - a) The acceptable range for line voltage is 105 Volts to 132 Volts.
 - 2) Percent Voltage Drop under 15 Ampere Load:
 - a) A voltage drop of 6 percent or higher under a 15 Ampere load is unacceptable.
 - 3) Ground Impedance:
 - a) Ground impedance values up to 2 Ohms are acceptable.
 - 4) Ground-Fault Circuit Interrupter (GFCI) Trip:
 - a) The ground-fault circuit interrupter (GFCI) tripping values specified in UL 1436 and UL 943 are acceptable.

3. Inspections:



- a. Convenience Receptacle Inspections:
 - 1) Using the test plug, verify that each device and its outlet box are securely mounted.

B. Non-Conforming Work

- 1. When Work is determined to be non-conforming, correct circuit conditions, remove malfunctioning units and replace the malfunctioning units with new ones, and retest the devices as specified herein.

3.06 ADJUSTING

- A. Adjust the locations of floor service outlets to suit the arrangement of partitions and furnishings.

3.07 PROTECTION

- A. Take steps to ensure that devices and their boxes are protected during construction activities.
 - 1. Do not place wall finish materials over device boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for the wiring devices that includes labeling conditions in all manufacturers' packing label warnings and instruction manuals.
 - 2. Submit the operation and maintenance data for the wiring devices to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16145

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following lighting control devices:
 - a. Time switches.
 - b. Indoor occupancy sensors.
 - c. Lighting contactors.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01770 - Closeout Procedures.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 16075 – Electrical Identification.
 - 5. Section 16120 - Conductors and Cables.
 - 6. Section 16130 - Raceway and Boxes.
 - 7. Section 16140 - Wiring Devices.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. BAS: Building automation system.
 - 3. DC: Direct electric current.
 - 4. LED: Light-emitting diode.
 - 5. PIR: Passive infrared.
 - 6. SPDT: Single pole, double throw.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. High-Inrush Ballast: A ballast having a 15 percent or less total harmonic distortion of the normal load current.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 3. National Electrical Contractors Association (NECA):



- a. ANSI/NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
- 4. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - a. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
- 6. Underwriters Laboratories, Inc. (UL):
 - a. UL 508 - Standard for Industrial Control Equipment.
 - b. UL 773A – Standard for Nonindustrial Photoelectric Switches for Lighting Control.
 - c. UL 917 - Standard for Clock-Operated Switches.
 - d. UL Online Certifications Directory,
<http://www.ul.com/regulators/quickguide.html>.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.
 - 2. Coordinate the required supporting wiring, raceway, and box sizes with the lighting control devices.
- B. Sequencing:
 - 1. Install the required supporting raceway and boxes prior to the scheduled installation of the lighting control devices.
 - 2. Install lighting control devices after all wall preparation, including painting, is complete.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Time switches.
 - 2) Indoor occupancy sensors.
 - 3) Lighting contactors.
 - 4) Power wiring.
 - 5) Class 1 control cables.
 - 6) Class 2 and Class 3 control cables:



- b. Shop Drawings:
 - 1) Occupancy and light-level sensors.
- c. Certificates:
 - 1) Electrical listing and labeling.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Sensor manufacturer's written instructions for the sensors.
 - 2) Lighting control device manufacturer's written instructions for sizing the conductors.
 - 3) Conductor manufacturer's written instructions for separating the conductors.
 - b. Site Quality Control Submittals:
 - 1) Field quality-control test reports.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Lighting control devices.

1.05 QUALITY ASSURANCE

- A. Certifications:
 - 1. Electrical Listing and Labeling:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.



1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
- B. Storage and Handling Requirements:
 - 1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 2. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with requirements specified for wiring devices in NFPA 70.
- C. Design Criteria:
 - 1. Product Data:
 - a. Submit manufacturers Product Data for each type of lighting control device product proposed for the Work of this Section to the Program/Project Manager for approval.
 - 2. Shop Drawings:
 - a. Submit Shop Drawings for occupancy and light-level sensors showing installation details, including interconnection diagrams showing field-installed wiring, to the Program/Project Manager for approval.
- D. Materials:



1. Time Switches:
 - a. Provide a type of electromechanical-dial time switch complying with the requirements specified in UL 917, and having an astronomic time dial that makes the time switch self-adjusting for seasonal changes and automatically adjusts on-off times as the days grow shorter or longer.
 - b. Eight-Day Program:
 - 1) Provide time switches having an eight-day program uniquely programmable for each weekday and holidays.
 - a) Include provisions for a skip-a-day mode.
 - c. Reserve Carryover Mechanism:
 - 1) Provide time switches having wound-spring a reserve carryover mechanism to keep time during power failures.
 - a) Provide a reserve carryover mechanism capable of keeping time for a minimum of 16 hours.
 - d. Contact Configuration:
 - 1) Provide single pole, double throw (SPDT) time switch contacts.
 - e. Contact Rating:
 - 1) Provide contacts rated for 30-Amperes inductive or resistive current, 240-Volt AC voltage.
 - f. Circuitry:
 - 1) Provide time switches having circuitry allowing connection of a photoelectric relay as a substitute for the on-off function of a program.
 - g. Manufacturers:
 - 1) Area Lighting Research, Inc., Tyco Electronics, <http://energy.tycoelectronics.com>.
 - 2) Grässlin Controls Corporation; part of Intermatic, Inc., www.intermatic.com/products/grasslin.aspx.
 - 3) Leviton Manufacturing Company, Inc., www.leviton.com.
 - 4) Philips Lightolier®, a Koninklijke Philips Electronics N.V. Brand, www.lightolier.com.
 - 5) Lithonia Lighting®, a division of Acuity Brands Lighting, Inc., www.lithonia.com.
 - 6) Paragon® Electrical Products; Invensys Controls, www.icca.invensys.com/paragon/inndex.htm.
 - 7) Square D; a brand of Schneider Electric, www.schneider-electric.us.
 - 8) TORK®, NSi Industries, LLC, www.tork.com.
 - 9) Touch-Plate® Technologies, www.touchplate.com.
 - 10) Watt Stopper, <http://www.wattstopper.com>.
 - 11) Approved equal.
2. Indoor Occupancy Sensors:
 - a. Provide wall- or ceiling-mounting, solid-state indoor occupancy sensors complying with the requirements specified in UL 773A, and having a separate relay unit.



- 1) Operation:
 - a) Unless otherwise indicated, provide indoor occupancy sensors that turn the lights on when the covered area is occupied, and that turn the lights off when the covered area is unoccupied.
 - (1) For turning the lights off, provide a time delay adjustable over a minimum range of 1 to 15 minutes.
- 2) Sensor Output:
 - a) Provide indoor occupancy sensors having contacts rated to operate the connected relay.
- 3) Relay Unit:
 - a) Power the sensor from the relay unit.
 - (1) Provide a 24-Volts DC, 150-milliampere, Class 2 power source as defined by NFPA 70 to supply power to the sensor.
 - b) Provide the relay unit with dry contacts rated for a ballast load of 20-Amperes at 120- and 277-Volts AC, for 13-Amperes tungsten at 120-Volts AC, and for 1 horsepower at 120-Volts AC.
- 4) Mounting:
 - a) Sensor:
 - (1) Provide a sensor suitable for mounting in any position on a standard outlet box.
 - b) Relay:
 - (1) Provide a relay externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c) Time-Delay and Sensitivity Adjustments:
 - (1) Mount the time-delay and sensitivity adjustments recessed and concealed behind a hinged door.
- 5) Indicator:
 - a) To show when motion is being detected during testing and normal operation of the sensor, provide a light-emitting diode (LED).
- 6) Bypass Switch:
 - a) Provide a bypass switch capable of performing an override of the on function in case of sensor failure.
- b. Dual-Technology Type Indoor Occupancy Sensors:
 - 1) Provide ceiling mounting dual-technology type indoor occupancy sensors capable of detecting occupancy by using a combination of passive infrared (PIR) and ultrasonic detection methods in the area of coverage.
 - a) Provide dual-technology type indoor occupancy sensors capable of allowing the particular technology or combination of technologies that control the on-off functions to be selectable in the field by operating the controls on the unit.
 - 2) Sensitivity Adjustment:



- a) Provide separate sensitivity adjustment for each sensing technology.
 - 3) Detector Sensitivity:
 - a) Provide dual-technology type indoor occupancy sensors capable of detecting occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 square inches, and of detecting a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical direction at an approximate speed of 12 inches per second.
 - 4) Detection Coverage (Standard Room):
 - a) Provide dual-technology type indoor occupancy sensors capable of detecting occupancy anywhere within a circular area of 1000 square feet when mounted on a 96-inch-high ceiling.
- c. Manufacturers:
 - 1) Hubbell Incorporated, www.hubbell.com.
 - 2) Leviton Manufacturing Company, Inc., www.leviton.com.
 - 3) Lithonia Lighting®, a division of Acuity Brands Lighting, Inc., www.lithonia.com.
 - 4) Cooper Industries, Inc., <http://greengate.coopercontrol.com/cooperControls>.
 - 5) RAB Lighting, Inc., www.rabweb.com.
 - 6) Sensor Switch®, an Acuity Brands Company, www.sensorswitch.com.
 - 7) TORK®, NSi Industries, LLC, www.tork.com.
 - 8) Watt Stopper, <http://www.wattstopper.com>.
 - 9) Approved equal.
- 3. Architectural Control Processor Modules
 - a. Control Processor Modules
 - 1) The Architectural Control Processor shall be the Unison Paradigm Series, P-ACP Control Processor as manufactured by Electronic Theatre Controls, Inc., or equal.
 - 2) Mechanical
 - a) The Architectural Control Processor (ACP) assembly shall be designed for use in DRd Series Power Enclosures and ERn Series Control Enclosures.
 - b) The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.
 - c) ACP module electronics shall be contained in a plug-in assembly.
 - (1) The module shall be housed in a formed steel body and contain no discrete wire connections.
 - (a) No tools shall be required for module removal or insertion.



- 3) The ACP shall be convection cooled.
- 4) User Interface
 - a) The ACP shall utilize a backlit liquid crystal display capable of graphics and eight lines of text.
 - b) The ACP shall provide an alpha-numeric keypad for data entry and navigation
 - c) The ACP shall provide a touch-sensitive control wheel for navigation.
 - d) The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.
 - e) The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.
 - (1) The backlight shall have a user selectable time out, including no time out.
- 5) The ACP shall provide a front-panel RJ45 receptacle for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.
 - a) The RJ-45 receptacle shall be secured behind the locking door.
- 6) The ACP shall provide a Secure Digital (SD) Removable Media slot on the front panel for transfer of configuration data.
 - a) The SD slot shall be secured behind the locking door.
- 7) The ACP shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
 - a) The USB port shall be secured behind the locking door.
- 8) Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
 - a) The ACP shall provide a Compact Flash (CF) Card as backup flash memory and storage.
 - b) The CF Card is located in the back of the ACP, and can be accessed only by removing the ACP.
 - c) The ACP data can be exchanged by inserting the CF card into another ACP.
- b. Electrical
 - 1) The ACP shall require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.
 - 2) The ACP shall require low-voltage power supplied by the Dimming or Control enclosure.
 - 3) The ACP shall be hot-swap capable.
 - 4) The ACP shall support Echelon LonTalk with LinkPower communications with control stations and other remote devices, including button stations, button/fader stations, Touchscreen stations, sensors, and third party LonMARK compliant products.
 - a) The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471



- (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit. Touchscreen stations, interface stations and portable stations connectors will also require (2) #16 AWG wires.
- b) The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
 - c) Link power wiring shall permit a total wire run of 1640 ft. (500m) without a repeater. Repeater option modules shall be available to increase wiring maximums in increments of 1640 ft. (500m)
 - d) Link power wiring between stations shall not exceed 1313 ft. (400m).
- 5) The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.
 - 6) The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.
 - 7) The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.*
 - a) *When used in a Dimming Enclosure, the second port is always an output port.
 - 8) The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.
 - 9) The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.
- c. Functional
- 1) Capacity
 - a) Shall support 1024 channels of control
 - b) Shall support 2 physical DMX ports, each of which may be configured as an input or output
 - 2) System
 - a) Runtime application shall utilize support Net3 system interoperability
 - b) System shall support the use of Network Time Protocol for real time clock synchronization
 - c) System shall support remote firmware upload an over Ethernet connection from a connected PC running the Light Designer software or another connected processor.
 - d) System shall support local firmware upload from removable media (SD Card, USB Flash Drive)
 - 3) Diagnostics
 - a) Shall output an Event log
 - b) Standard log shall store a fixed-length history of recent activity



- c) Separate critical log shall only store important messages (such as boot-up settings)
- 4) Configuration Data
 - a) Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application
 - b) Configuration Data can be retrieved from another Paradigm Processor
 - c) A Paradigm Processor shall make its configuration data available for retrieval by another Processor as a backup/recovery mechanism
 - d) Configuration Data shall be stored on solid-state media that can be removed to facilitate transfer between Processor units
 - e) Configuration Data may be loaded to and from removable media access provided on front panel
 - f) Configuration Data for the entire System shall be available for download from any single Processor
 - g) Shall store configuration data for Dimming enclosure processors and shall make available for download
- 5) Scalability
 - a) Adding additional Processors to a System shall proportionately increase its overall capabilities up to a maximum project size
 - b) The maximum number of Processors configured as a project shall be at least 12. The use of a Central Control Processor (P-CCS) shall allow for larger system sizes up to 72 processors
 - c) Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information
 - d) Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made
 - e) Failure of a single Processor shall not prohibit continuing operation of the remaining Processors
 - f) It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems
- 6) Local User Interface
 - a) Shall provide access to Processor setup (IP address)
 - b) Shall provide access to Processor status and diagnostics
 - c) Where the Processor is installed within a Dimming enclosure, shall provide access to Dimming enclosure setup, status and diagnostics
 - d) Shall provide control functionality for Control Channels, Zones, Fixtures, Groups, Presets, Macros, Walls and Sequences within the current configuration.
 - e) Shall provide functionality to schedule astronomical and real-time events (add/edit/delete)



- f) Shall allow for display of local DMX information
- g) Shall allow for transfer of log files to local removable media
- h) Shall allow to perform firmware upgrades for connected Dimming enclosures
- i) Shall allow for transfer of configuration to and from Dimming enclosures using removable media
- j) Shall allow for transfer of configuration to and from LCD Stations using removable media
- k) Shall allow for binding of Stations
- 7) Access Controls
 - a) There shall be 2 user accounts - Administrator, and User with separate password protection
 - b) Account and password settings shall be local to each Processor
 - c) Access Controls shall be applied to certain areas of the Paradigm Local User Interface and Web Interface
- 8) Web User Interface
 - a) Shall be an internal web server accessible via Ethernet port
 - b) Shall support common web browsers on Windows and Mac platforms
 - c) Shall provide functionality to Activate and Deactivate Presets
 - d) Shall provide functionality to schedule timed events (add/delete)
 - e) Shall display status information
 - f) Shall display log files
 - g) Shall allow for configuration of Processor settings (date, time)
 - h) Shall allow for upload and download of configuration data
 - i) There shall be links to other web-enabled devices in the System, including other Paradigm Processors
- 9) Stations
 - a) Stations shall be connected to a Paradigm Processor via a LinkPower network or Ethernet
 - b) Station discovery and binding shall be accomplished from the Local User Interface or Light Designer
- 10) Net3 and ACN Devices
 - a) Paradigm Processors shall provide DMX-Net3 gateway functionality
 - b) Net3 devices shall be connected to and controlled from the Processor via Ethernet
 - c) It shall be possible to send and receive Macro triggers defined within the System configuration via Net3
 - d) There shall be support for a maximum of 1024 Streaming ACN outputs configured to a maximum of 12 universes per Processor
- 11) Operation



- a) When contained in a dimming enclosure, a snapshot of the dimming enclosure output data shall be stored in persistent memory so that hardware can access it for immediate output on boot
 - b) DMX output refresh rate shall be configurable
 - c) There shall be support for 16-bit DMX Attributes
 - d) DMX inputs may be patched to DMX and Streaming ACN outputs as external sources
 - e) Streaming ACN inputs shall be patched to DMX outputs (gateway) as external sources
 - f) Where there are multiple external sources then priority and HTP shall be used to perform arbitration
 - g) External and internal sources shall be arbitrated based on user-selection of standard or custom rules
 - h) On Preset Record, the values of Attributes within the Preset shall be updated to reflect the current output
 - i) The total output may be the combination of many different Presets running concurrently
 - j) There shall be no hard limit on number of concurrent cross fades
 - k) Multiple Presets controlling the same Attribute shall first interact based on priority and second based on Latest Takes Precedence (LTP) or Highest Takes Precedence (HTP)
 - l) LTP and HTP operation shall be supported simultaneously and interact (at the same priority) using HTP
 - m) Settings due to LTP Presets may be automatically discarded from operation when overridden
 - n) It shall be possible to specify that a Preset or Attribute Control will persist when overridden
 - o) A Preset may be designated as an HTP Override and shall cause HTP values to be discarded
 - p) It shall be possible to modify the rate of a Preset (Cross fades, Effects) from a Control within the System
 - q) Each Preset shall have a status that can be Activated, Deactivated or Altered
 - r) Preset status may be set based on matching levels in the current output as an option
 - s) On startup, the System shall be capable of automatically executing timed events within the previous 24 hours to synchronize its initial output state with the current time of day
- 12) Serial Input/Output
- a) RS232 shall support 8-bit word length, parity selection and 1 or 2 stop bits
 - b) RS232 shall support baud rates from 4800 to 115,200 bps
 - c) Serial input and output messages are fully customizable



- d) Serial output messages can be generated by any Control or Event.
- 4. Unison ERn Series Control Enclosures
 - a. Control Enclosures
 - 1) The control enclosure shall be the Unison ERn Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or equal.
 - b. Mechanical
 - 1) The External Processing enclosure shall be a surface mounted panel constructed of 18 gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.
 - a) The enclosure door shall have an opening to allow limited access to the control module face panel.
 - b) Enclosures shall be convection cooled without the use of fans.
 - c. Control Enclosures shall be sized to accept one or two Control Processors and one or two Station Power Modules, including various options and accessories.
 - 1) The Control Enclosure for a single control processor (ERn2) shall support a single Station Power Supply module; The Control Enclosure for 2 control processors (ERn4) shall support a quantity of 2 modules.
 - d. All enclosure components shall be properly treated and finished.
 - 1) Exterior surfaces shall be finished in fine textured, scratch resistant, powder based epoxy paint.
 - 2) Enclosure(s) shall also be available in a 19" rack mounted (RM) version.
 - a) Rack-mounted version shall have an independent enclosure suspension kit, with a full height, locking door/cover attached to the kit.
 - b) Rack-mounted version shall have an opening to access the control module face panel, and openings to view indicators on option modules.
 - 3) Enclosure dimensions and weights (without modules) shall not exceed:
 - a) ERn2 - 15" W x 9" H, 10" D, 15 lb
 - b) ERn2-RM - 19" W 11"H 10" D, 20 lb.
 - c) ERn4 - 15" W x 14" H x 10" D, 20 lb.
 - d) ERn4-RM - 19" W x 16" H x 10" D, 25 lb.
 - 4) Top, bottom, and side knockouts shall facilitate conduit entry.
 - 5) Enclosures shall be designed to allow easy insertion and removal of all control and option modules without the use of tools.
 - a) Supports shall be provided for precise alignment of modules into power and signal connector blocks.
 - b) With modules removed, enclosures shall provide clear front access to all power and control wire terminations.



- e. Option Modules
 - 1) Ethernet Switch
 - a) The Control Enclosure shall support an optional 5-port Ethernet Switch, with at least 4 ports supplying Power over Ethernet (PoE).
 - b) The Ethernet Switch module shall be 100BaseTX, auto MDI/MDIX, 802.3af PSE compliant.
 - c) The Ethernet Switch module shall contain power, status, and activity indicators. All indicators shall be visible when the enclosure door is open for both rack and wall mounted ERn.
 - 2) Redundant Power Supply (RRPS)
 - a) The Control Enclosure shall support an optional redundant power supply which shall automatically provide power to the control electronics upon failure or removal of the primary power supply.
 - b) The redundant power supply shall assert itself seamlessly without a loss of power to the control electronics.
 - c) The redundant power supply shall seamlessly remove itself when the primary power supply is reengaged.
 - d) The redundant power supply shall provide visible indication that it is active.
 - 3) Station Bus Repeaters (ERn4 only)
 - a) The Control Enclosure shall support an optional module to expand the station bus length an additional 400 meters, and the station count an additional 30 stations (60 maximum per processor/enclosure)
 - b) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.
 - 4) Station Bus Dual Repeaters (ERn4 only)
 - a) The Control Enclosure shall support an optional module to expand the station bus length to two additional 400 meter segments (a total of 1200 meters from a single enclosure, and the station count to 60 stations (60 maximum per processor/enclosure).
 - b) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.
 - 5) Accessories
 - a) RideThru Option (RTO)
 - (1) The Control Enclosure shall support an optional, short-term back-up power source for the control electronics.
 - (2) RideThru Option (RTO) provides power for controls electronics during brief power outages or drop outs.
 - (3) The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly



transitioning the supply power for the control electronics power to itself.

- (4) The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.

- (5) The short-term back-up power source shall support the control electronics for at least 10 seconds.

b) BatteryPack Option (BPO)

- (1) The Control Enclosure shall support an optional, long-term back-up power source for the control electronics.

- (2) The long-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.

- (3) The long-term back-up power source shall supply power to the control electronics for at least 90 minutes.

- (4) The long-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.

- (5) A test switch/indicator shall be available without opening the rack door or removal of any modules/components.

f. Electrical

- 1) External Processing enclosures shall be available in 100, 120, 230 and 240 volt, single-phase configurations.

- 2) External Processing enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input and control wiring.

- 3) External Processing enclosures shall be designed to support the following wire terminations:

- a) AC (single phase)
- b) Echelon link power (Belden 8471 or equivalent)
- c) 24Vdc (2- 16AWG Wire)
- d) DMX512A Port A (In or Out) (Belden 9729 or equivalent)
- e) DMX512A Port B (In or Out) (Belden 9729 or equivalent)
- f) RS232 Serial In/Out (Belden 9729 or equivalent)
- g) Unshielded Twisted Pair (UTP) Category 5 Ethernet
- h) Contact Closure In (14AWG to 26AWG Wire)
- i) Contact Closure Out (14AWG to 26AWG Wire)
 - (1) Contact Closure Out shall provide 1A @ 30vDC

- 4) Station Power Modules

- a) Station power supply modules shall provide LinkPower for at 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.

- b) Station power repeater modules shall provide LinkPower for 30 stations and 1.5A@24VDC of Auxiliary (AUX) power.



- c) Station power module shall support over-current/short protection for LinkPower and Aux. LinkPower shall support fault detection on each leg of the balanced data bus.
 - 5) All control wire connections shall be terminated via factory provided connectors.
 - g. Thermal
 - 1) Ambient room temperature: 0-40°C / 32-104°F
 - 2) Ambient humidity: 10-90% non-condensing
- 5. Button and Fader Stations
 - a. Stations
 - 1) Button Stations
 - a) The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
 - b) Mechanical
 - (1) Unison Heritage Button stations shall operate using up to ten programmable buttons.
 - (2) All button stations shall be available with white, cream, ivory, gray or black faceplates, and buttons.
 - (a) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
 - (3) Stations shall have indicator lights at each button or fader.
 - (a) Indicators shall be comprised of red, green and blue LED's
 - (b) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
 - (4) All faceplates shall be designed for flush or surface mounting.
 - (5) Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
 - (6) Station faceplates shall be indelibly marked for each button or fader function.
 - (7) The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
 - (8) All Button stations shall be designed to accept the infrared signal from a remote hand-held IR transmitter.
 - (a) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.
 - (9) IR Transmitters shall be available in five or ten button configurations.
 - (a) IR transmitters shall be mounted in a hand-held black plastic controller.



- (b) Transmitter dimensions shall be 1.875" wide, 6.625" long and 0.60" deep.
- c) Electrical
 - (1) Unison control station wiring shall be an Echelon® Link power network.
 - (a) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
 - (b) Network wiring may be bus, loop, home run, star or any combination of these.
 - (c) Wiring termination connectors shall be provided with all stations.
 - (2) Button Stations shall offer the following Regular markings
 - (a) UL and cUL LISTED
 - (b) CE Market
 - (c) RHoS and WEE Compliant
- d) Functional
 - (1) The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
 - (a) System presets shall be programmable via Button stations, Touchscreen stations, and LightDesigner software.
 - (b) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
 - (c) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.
 - (2) System macros and sequences shall be programmable via LightDesigner system software.
 - (a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
 - (b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
 - (3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.



- (a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
 - (b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
 - (4) Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
 - (a) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
 - (b) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.
 - (5) Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.
- 2) Fader Stations
 - a) The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
 - b) Mechanical
 - (1) Unison Heritage Fader Stations shall operate using up to sixteen programmable faders and twelve programmable buttons.
 - (2) All fader stations shall be available with white, cream, ivory, gray or black faceplates, fader knobs, and buttons.
 - (a) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
 - (3) Fader stations shall utilize standard 45-millimeter slide potentiometers.
 - (4) Stations shall have indicators lights at each button or fader.
 - (a) Indicators shall be comprised of red, green and blue LED's



- (b) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
- (5) All faceplates shall be designed for flush or surface mounting.
- (6) Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
- (7) Station faceplates shall be indelibly marked for each button or fader function.
- (8) The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
- (9) Fader stations shall be designed to accept the infrared signal from a remote hand-held IR transmitter.
 - (a) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.
- (10) IR Transmitters shall be available in five or ten button configurations.
 - (a) IR transmitters shall be mounted in a hand-held black plastic controller.
 - (b) Transmitter dimensions shall be 1.875" wide, 6.625" long and 0.60" deep.
- c) Electrical
 - (1) Unison control station wiring shall be an Echelon® Link power network.
 - (a) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
 - (b) Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
 - (c) Network wiring may be bus, loop, home run, star or any combination of these.
 - (d) Wiring termination connectors shall be provided with all stations.
 - (2) Fader Stations shall offer the following Regular markings
 - (a) UL and cUL LISTED
 - (b) CE Market
 - (c) RHoS and WEE Compliant
- d) Functional



- (1) The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface, or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
 - (a) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
 - (b) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
 - (c) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.
- (2) System macros and sequences shall be programmable via LightDesigner system software.
 - (a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
 - (b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
- (3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.
 - (a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
 - (b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
- (4) Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
 - (a) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.



- (b) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.
 - (5) Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.
- 3) Locking Covers
 - a) The Lighting Control Station Locking Covers shall be the Unison Heritage UH Series as manufactured by Electronic Theatre Controls, Inc., or equal.
 - b) Mechanical
 - (1) Locking covers shall be available in Sliding Locking for flush mount applications and Hinged Locking for flush and surface mount applications
 - (2) Sliding Locking Covers shall
 - (a) Be available with white, cream, ivory, gray or black faceplates.
 - (b) Be constructed of Extruded Aluminum with ABS plastic end caps
 - (c) Provide a smoked Plexiglas window to allow for viewing control status and use of IR remote without opening cover
 - (3) Hinged locking covers shall:
 - (a) Be available in standard black powder coat finish
 - (b) Be constructed of 18-gauge steel and finished in standard black powder coat paint, or custom color as specified.
 - (c) Provide a clear Plexiglas window to allow for viewing control status and use of IR remote without opening cover
 - (d) Use internal Hinge that is not accessible when the cover is closed
 - (4) Standard colors shall conform to the RAL CLASSIC Standard.
 - (5) Locking covers of the same type shall be keyed alike
 - (6) The manufacturer shall supply back boxes for all hinged locking covers
 - c) Functional
 - (1) All locking covers shall utilize 90-degree locking mechanisms
 - (a) Keys shall be held captive in locks when covers are unlocked.



- (2) Locking covers shall allow for easy viewing of system status without opening the cover
 - (3) Locking covers shall support IR remote activation of configured system functions without opening door
- 6. Lighting Control System Configuration and Control Software
 - a. Configuration and Control Software
 - 1) System Configuration
 - a) The Architectural Control System Configuration software shall be the Unison Paradigm LightDesigner as manufactured by Electronic Theatre Controls, Inc., or equal.
 - b) Definitions
 - (1) A System is the configuration of one or more Paradigm Processors
 - (2) A Fixture is a controllable entity with one or more Attributes
 - (3) An Attribute is a parameter of control such as Intensity, Pan or Gobo select
 - (4) A Group is a selection of Fixtures that can be stored and recalled
 - (5) A Space is defined area where other System objects reside. A Space defines the scope of Control for other objects.
 - (6) Room Combine is functionality enabling the scope of control to vary in a pre-defined way based on the current status of a moveable Wall or Walls
 - (7) A Control is a single point of input to the System (e.g. Button, Fader, SerialPort
 - (8) An Indicator is a single point of feedback from the System (e.g. LED, Label on LCD)
 - (9) A Station has an arrangement of Controls and Indicators
 - (10) A Page stores the assignment of function to Controls and Indicators of a particular Station and their properties (e.g. lockout threshold)
 - (11) Actions are items of functionality that can occur within a running Paradigm system in response to events (e.g. button presses, timed events)
 - (12) Preset is a container of Attribute settings (levels) and timings that can be stored and recalled
 - (13) A Sequence is a series of connected steps referencing Presets along with additional timing information



- (14) Effects are Attribute settings that result in continually varying levels following a specified curve and using additional timing parameters (e.g. period, offset)
 - (15) Palette is a container of Attribute settings (levels) that can be referenced from Presets, allowing a change in the Palette to globally modify referenced Presets.
 - (16) Macros are user-defined operations built up as a sequence of Actions that can be recalled
 - (17) Binding is the process of associating a logical instance of a device within the configuration with a physical device discovered at runtime
- c) Environment
- (1) Shall be possible to work with multiple System configurations simultaneously
 - (2) There shall be clipboard functionality (cut, copy, paste) for entire objects (e.g. Presets, Stations), settings (e.g. Attribute levels) and text
 - (3) There shall be undo and redo functionality where persistent changes are made to the System configuration (but not application settings or playback state)
 - (4) There shall be an auto-backup feature
 - (5) The application interface shall be based around (i) a tree-view; (ii) a workspace area; (iii) a properties inspector; (iv) item selector.
 - (6) It shall be possible to represent data about the workspace area graphically (plan) or in tabular form
 - (7) Plan views shall support zoom
 - (8) Plan views shall support a layout grid with user-defined spacing and color with associated snap-to-grid functionality
 - (9) The properties inspector shall be used to view and modify the properties of one or multiple objects
 - (10) There shall be 2 modes of operation that expose progressively more in-depth functionality (Normal/Advanced)
 - (11) It shall be possible to enter User-configurable names in any language supported by their operating system (e.g. encoded as UTF8)
 - (12) User-configurable names shall be limited to 64 display characters each
 - (13) There shall be provision for help functionality to be accessed from within the application



- d) System Configuration
 - (1) It shall be possible to create Spaces
 - (2) It shall be possible to add Fixtures by selecting a Fixture Template from the provided library and create custom Fixtures
 - (3) It shall be possible to add Stations by selecting a Station Definition from the provided library and create custom Stations
 - (4) It shall be possible to create a System based on data imported from a defined documentation format (e.g. CSV, XML)
 - (5) It shall be possible to export System configuration data to a defined documentation format (e.g. CSV, XML)
 - (6) There shall be a wizard to assist with the initial setup of a System including Project data entry, Space creation, network configuration, and zone creation.
 - (7) There shall be a straightforward process for the assignment of Fixtures and Stations to particular Processors
 - (8) There shall be a 2-dimensional plan view that displays the layout of Spaces
 - (9) A Space shall be displayed as a user-configurable polygon with straight edges
 - (10) The plan shall display Fixtures and Stations located within Spaces
 - (11) The plan shall display Walls between Spaces and their current state (open, closed)
 - (12) Items displayed on the plan may be arranged using standard graphical interaction methods (e.g. drag-and-drop)
 - (13) It shall be possible to import images JPEG, BMP and GIF formats as a background image to the plan view
 - (14) It shall be possible to create Walls that accomplish Room Combine between Spaces
 - (15) It shall be possible to import Load Schedules, Equipment Lists and Presets from a spreadsheet to automatically create system objects and configuration parameters.
- e) Fixture Configuration
 - (1) There shall be functionality to patch Fixtures to DMX and Streaming ACN
 - (2) There shall be support for Fixtures with split patches (e.g. VL5)



- (3) There shall be support for multiply-patching a Fixture
- (4) It shall be possible to swap pan and tilt axes for a moving-light Fixture
- (5) It shall be possible to specify a minimum and maximum value for an Attribute
- (6) It shall be possible to specify a minimum fade time for an Attribute
- (7) It shall be possible to invert the range of values for an Attribute
- (8) It shall be possible to specify a default value for an Attribute
- (9) It shall be possible to specify a dimmer curve for an intensity Attribute
- f) Design and Simulation
 - (1) There shall be a tabular view of Fixture Attributes within Spaces
 - (2) There shall be control of Zones (as a type of Fixture)
 - (3) There shall be control of LED arrays (as a type of Fixture)
 - (4) There shall be control of moving lights (as a type of Fixture)
 - (5) There shall be independent control of every Attribute of a Fixture
 - (6) Appropriate graphical controls shall be provided for non-intensity Attributes (e.g. color picker)
 - (7) It shall be possible to create Groups as a selection shortcut
 - (8) The plan shall show the current status of Room Combine
 - (9) The plan shall show simulation feedback for Fixtures in a graphical form
 - (10) Feedback values for Attributes shall be displayed in terms of real-world units where an appropriate real-world unit and mapping is available (e.g. pan in degrees)
 - (11) Control events may be simulated by clicking on a representation of the Station in at least the plan view
 - (12) The simulation may be linked to the actual online System to synchronize playback and inject control events (live control)
- g) Presets
 - (1) There shall be provision to record a Preset based on current Attribute settings
 - (2) There shall be a display of Presets that affect Fixtures in the Space being worked with and their activation status



- (3) A Preset may store a reference to a Palette as an Attribute setting
- (4) Presets may be displayed and modified in tabular form (spreadsheet)
- (5) Timing in Presets may be set on an individual Attribute basis
- (6) Timing settings shall include a fade time, a delay time and a fade profile
- (7) All Presets may include split timing
- (8) Presets may be applied in a Latest Takes Precedence (LTP) or Highest Takes Precedence (HTP) manner
- (9) It shall be possible for all Presets to include Effects
- (10) Each Effect shall have a Curve and parameters (to include size, period, offset and repeat count)
- (11) There shall be support for a flicker effect
- (12) There shall be a provision to create Sequences from Presets
- (13) It shall be possible for a Sequence to be displayed and modified as a timeline display
- (14) It shall be possible for any step of a Sequence to trigger a defined Action
- (15) The end state of a Sequence shall be user configurable (e.g. release, loop, hold at end)
- h) Stations and Events
 - (1) Can assign functionality (Actions) to Controls and Indicators on a Page for a particular Station
 - (2) Stations may have multiple Pages that can be switched between at runtime
 - (3) Controls shall have a configurable event handler (Script) that determines the nature of the control (e.g. momentary vs. maintained button)
 - (4) Actions initiated from a Station shall, by default, be restricted to affecting the Space containing the Station
 - (5) A Control may be configured so that the Actions it triggers behave as if initiated from a specified Space anywhere in the System
 - (6) Controls shall have a priority that is used when performing operations (e.g. preset activation, fader attribute control)
 - (7) It shall be possible to specify timed events (including repeat intervals hourly, daily, weekly, etc.)
 - (8) It shall be possible to specify astronomical timed events



- (9) Serial (e.g. RS232, Ethernet) input data shall be treated as a Control event and shall be handled through use of Script (standard or custom)
- (10) There shall be support for Occupancy functions using proximity sensors connected via Echelon LonTalk or a Contact Interface
- (11) There shall be support for Daylight Harvesting functions using photo sensors connected via Echelon LonTalk or a Fader Interface.
- (12) There shall be Override functionality that can be applied to any Control or Event
- (13) There shall be Lock Out functionality for Controls using 3 distinct lockout variables
- (14) Direct control of Attributes can be assigned to Controls (e.g. buttons, faders)
- (15) Mastering of Intensity for Fixtures, Groups or Presets can be assigned to Controls
- (16) There shall be extensible support for third-party LonMark devices
- (17) A physical Lon native Station that is portable may automatically bind to different logical Stations within the configuration based on an established physical LON connection
- (18) There shall be an option to assign default functionality to Controls and Indicators of a Station automatically when it is added to the configuration and update it as the configuration changes
- (19) There shall be an option to generate a graphical configuration for a Touchscreen automatically based on the current configuration and update it as the configuration changes
- (20) It shall be possible to import .ics files for display of holidays or other notable dates
- i) Actions
 - (1) There shall be a standard Action for toggling the Intensity Attribute of a Fixture or Group (Fixture Toggle)
 - (2) There shall be standard Actions for recalling Presets (Preset Recall)
 - (3) There shall be a standard Action for recording a Preset (Preset Record)
 - (4) There shall be standard Actions for controlling Sequences (Timeline Control)



- (5) There shall be standard Actions for changing Wall state (Wall Toggle)
 - (6) There shall be a standard Action for raising or lowering the intensity setting of a Fixture or Group
 - (7) There shall be a standard Action for raising or lowering the intensity setting of a Preset
 - (8) There shall be a standard Action that activates Faders within its scope (Manual)
 - (9) There shall be a standard Action that activates Faders on a target station and locks out other Stations within its scope (Take Control)
 - (10) There shall be a standard Action for setting lock out variables for a Station, within a Space or System-wide (Lock Out)
 - (11) There shall be a standard Action for enabling and disabling Overrides
 - (12) There shall be a standard Action for recalling a Macro (Call Macro, Macro Toggle)
 - (13) There shall be a standard Action for turning Off a particular Fixture, Group or Fixtures within a Space (Off)
 - (14) There shall be a standard Action for controlling Fixture or Group Intensity levels from a Fader
 - (15) There shall be a standard Action for controlling Preset Intensity levels from a Fader
 - (16) There shall be a standard Action for mastering Fixture or Group Intensity levels from a Fader
 - (17) There shall be a standard Action for modifying Preset fade times from a Fader
 - (18) There shall be a standard Action for modifying Preset rate from a Fader
 - (19) There shall be an equivalent standard Indicator behavior for every standard Action
 - (20) Qualified users may create custom Actions
- j) Macros
- (1) Users can create, store and recall Macros that are sequences of Actions (standard or custom)
 - (2) Macros may define separate sequences to occur when turned on and off (toggle)
 - (3) Macros may incorporate conditional statements based on current status of the System (e.g. comparisons such as $x > y$)



- (4) Conditional statements may be combinations of several simpler statements using logical operators (AND, OR)
- k) Script
 - (1) There shall be a mechanism for defining custom functionality using a scripting language
 - (2) The behaviors of Controls and Indicators may be customized through the use of Script
 - (3) Script may be used to define custom functionality (Actions) within the System
 - (4) Script shall allow new functionality to be defined in a manner that is reusable in different Systems
 - (5) Script shall support logical and arithmetic operations
 - (6) Script shall support direct access to System data using names
 - (7) Script shall support creating, reading and writing to persistent System-wide variables (registered variables)
 - (8) Script shall support timer functionality including the capability to cancel a running timer
 - (9) Script shall support logging functionality
 - (10) Standard functionality may be implemented as Scripts that will not be user modifiable
 - (11) A Custom Script may be copied from a suitable Standard Script to provide a starting point
 - (12) Script shall support reading data directly from connected interfaces (e.g. LON NVs, ACN properties, DMX inputs)
 - (13) Script shall support writing data directly to connected interfaces (e.g. LON NVs, ACN properties, DMX outputs, Serial ports)
 - (14) Script shall allow parsing of data (e.g. reading 8 contact inputs as individual bits from a byte of data)
- l) Network
 - (1) Shall display a topological view of Paradigm Processors and connected Stations
 - (2) Can associate a particular Station with a Paradigm Processor
 - (3) Shall report online status of Paradigm Processors and Stations
 - (4) Shall allow for configuration of network properties (IP) of Paradigm Processors
 - (5) Shall allow for upload of configuration data to all or individual Paradigm Processors



- (6) Shall allow for download of configuration data from Paradigm Processors
 - (7) Shall allow for download of logging data from Paradigm Processors
 - (8) Shall provide for performing firmware upgrades to Paradigm Processors
 - (9) Shall allow to perform firmware upgrades for Dimming enclosures using Paradigm Processors as proxies
 - (10) Shall allow for transfer of configuration to and from LCD Stations using Paradigm Processors as proxies
 - (11) Shall allow for discovery and binding of Stations
 - (12) There shall be a mode in which configuration changes are propagated to Processors as they occur without interrupting operation (live edit)
 - m) Reports
 - (1) It shall be possible to generate tabular reports and customize their layout and appearance
 - (2) It shall be possible to print reports
 - (3) It shall be possible to export reports to file (e.g. CSV)
 - (4) There shall be reports for Presets
 - (5) There shall be reports for Fixtures
 - (6) There shall be reports for Stations
 - (7) There shall be reports for Processors
 - (8) There shall be reports for Macros
 - n) Resources
 - (1) The installed package shall include a set of LCD Design Themes
 - (2) Effect Curves, Fade Profiles and Dimmer Curves shall use a common format and allow custom variants to be generated by the user
 - (3) Additional Fixture Templates may be defined by the user (custom Fixtures)
 - (4) Additional Station Definitions may be defined by the user (custom Stations)
 - o) Mosaic
 - (1) It shall be possible to add Mosaic systems to the configuration for triggering and status monitoring
 - (2) There shall be standard Actions and Indicator behaviors for Mosaic integration via Ethernet
- 2) Touchscreen Station Configuration



- a) The Architectural Control System Touchscreen Configuration software shall be the Unison Paradigm ControlDesigner as manufactured by Electronic Theatre Controls, Inc., or equal.
- b) The Unison Paradigm ControlDesigner software program shall be an application software package that facilitates off-line Unison Paradigm Touchscreen station configuration.
 - (1) Software setup shall include Configuration and Design Wizards, to create a graphical representation of a control environment.
 - (2) The software program shall be downloadable from the manufacturer's website free of charge.
- c) Functions
 - (1) Provides functionality to create and modify Pages for display on a specific type of LCD Station
 - (2) There shall be a wizard to assist with the creation of Pages
 - (3) A single configuration for an LCD Station shall be defined as a set of one or more Pages
 - (4) Each Page shall have a background that may incorporate multiple images or animations
 - (5) Pop-ups can be shown/hidden over any Page in a Configuration and more than one Popup can be shown at once
 - (6) Pages may have multiple design elements that may be Controls, Indicators or both
 - (7) Design elements shall have a user-defined size, position and z-order that cannot be changed from within the System
 - (8) Each design element shall have between 1 and 256 states, each of which can have a distinct appearance
 - (9) The appearance of a state can be taken from a Theme or imported image file
 - (10) There shall be support for import of at least JPG, PNG and GIF image formats
 - (11) Transparency shall be supported
 - (12) Animated images shall be supported
 - (13) Transitions between states of design elements can be animated
 - (14) Page transitions can be animated
 - (15) Design elements shall have a visibility group and threshold



- (16) Design elements that are Controls shall have a lockout group and threshold
- (17) All text shall have a user-definable font family, size, color and alignment
- (18) There shall be at least the following types of design elements
 - (a) Label
 - (b) Level Indicator
 - (c) Button
 - (d) Fader (straight and curved)
 - (e) Clock (analogue and digital)
 - (f) Numeric Keypad
 - (g) Tab widget
 - (h) Color Picker
 - (i) Error table
- (19) Themes shall define a collection of consistent appearances and sounds for design elements
- (20) It shall be possible to change the Theme used for a particular Station without modifying the underlying design elements
- (21) There shall be tools to assist with the creation of new Themes
- (22) Shall allow sounds to be associated with a particular Page
- (23) Shall allow sounds to be associated with state transitions of particular design elements
- (24) Sounds may be used to provide Touchscreen interaction feedback
- (25) A Page can be designated as the Stations inactivity Page
- (26) A Page can have a lockout group and threshold
- (27) A Tab can have a visibility group and threshold
- (28) There shall be a visualization interface for Page creation and editing
- (29) Standard graphical interaction methods (drag-and-drop) shall be used to arrange design elements on Pages
- (30) There shall be a layout grid with user-defined spacing and color with associated snap-to-grid functionality
- (31) It shall be possible to reuse the graphical layout of a configuration independent of any assigned functionality
- (32) The LCD Design functionality shall be part of a separate application that can be used alongside Light Designer
- (33) Pop-ups can be any fixed size up to the Page size



- (34) Pop-ups will have a fixed position on screen (but may move when being shown/hidden)
- 3) Minimum Computer Requirements
 - a) The software shall require the following minimum requirements:
 - (1) Windows 8, Windows 7 or Windows XP SP2 operating system
 - (2) 2 GHz Pentium 4 or better
 - (3) A minimum of 1 GB system memory
 - (4) A minimum of 1 GB hard drive space
 - (5) OpenGL graphics acceleration with a monitor capable of displaying at least 1024 x 768 screen resolution
 - (6) Keyboard and mouse
- 7. Wall Mount Relay Panel
 - a. General
 - 1) The wall mount relay panel shall be the Echo Relay Panel Feedthrough as manufactured by Electronic Theatre Controls, Inc., or equal. Panels shall be UL Listed (UL508 FILE #E92154) and CSA Approved, and shall be so labeled when delivered.
 - 2) The 24-relay panel shall consist of any quantity between one and twenty-four 20-amp relays, single- or double pole as required, control electronics, sub-panel, and enclosure.
 - 3) The 48-relay panel shall consist of up to forty-eight 20-amp relays, single- or double pole as required, a single control electronics, sub-panel, and enclosure.
 - b. Mechanical
 - 1) The small panel shall be 26.25" (622 cm) high by 17" (432 cm) wide and 6.3" (161 cm) deep and weigh no more than 45 pounds (20.5 kg). The large panel shall be 47.27" (1201 cm) high by 17" (432 cm) wide and 6.3" (161 cm) deep and weigh no more than 81 pounds (36.8 kg).
 - 2) It shall be constructed of 16-gauge steel. All panel components shall be properly treated, primed and finished in fine-textured, scratch resistant paint. The entire unit shall surface mount.
 - 3) Equally sized top, bottom, and side removable knockout panels shall facilitate conduit entry, with an internal pass-through plenum for side-by-side or top-to-bottom mounting. The front panel shall be easily removable as well for full front access to input, output and data connections.
 - 4) The unit shall ship with a cover complete with a locking door, allowing controlled access to the Class 2 wiring only.
 - 5) Optional center-pin reject security screws shall be available for all accessible screws.
 - 6) The panel enclosure shall be available separately from the sub-panel containing the control electronics to allow for pre-



installation. The panel shall be UL Listed to be available in this configuration.

c. Electrical

- 1) The panel control electronics shall operate on single phase, two wire + ground, 120, 230V, or 277V AC 60Hz, at an amperage sufficient to power the panel (8 amps max). Standard fault current protection shall be 5,000 AIC.
- 2) The individual relays shall be mechanically latching and capable of switching 20A at up to 300V circuits with no derating required for inductive lighting loads.
- 3) Optional dual space 277/480V 2 pole relay shall be mechanically latching and capable of switching 20A at up to 500V circuits.
- 4) Each relay shall have an integral manual override switch with on/off status indication.
- 5) The relay shall have the following minimum ratings:
 - a) 14000A Short Circuit Current Rating at 277V
 - b) 1500A short circuit current
 - c) 5000V RMS isolation
 - d) 300,000 mechanical cycles (600,000 operations)
 - e) 30,000 cycles inductive, Tungsten or motor
 - f) 20,000 cycles electronic (LED)
- 6) The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay period of 0.1 to 60 seconds, in 0.1 second increments, per relay.
- 7) All line terminals shall accept 10-14 AWG wire. The control wiring shall land on a removable header for easy contractor installation (On-board DMX, stations and Emergency Input terminations).
- 8) A voltage barrier shall be available to separate relays carrying different voltages in the same panel. The barrier shall be capable of installation, without tools, between any two relays, and shall allow up to eight barriers per panel (4 per side).

d. Functional

- 1) Panel setup shall be user programmable. The control interface shall provide the following relay setup features (per circuit):
 - a) Type (1 pole, 2 pole, or 3 pole)
 - b) Name
 - c) Circuit Number
 - d) DMX address
 - e) sACN address (network enabled panels only)
 - f) Space Number
 - g) Circuit Mode
 - (1) Normal (priority and HTP based activation and dimming)
 - (2) Latch-lock
 - (3) Fluorescent



- (4) DALI
 - h) On threshold level
 - i) Off threshold level
 - j) Include in UL924 emergency activation
 - k) Allow Manual
- 2) Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing and cannot assign each 0-10V output control to any internal relay shall not be acceptable
- 3) The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay per relay using a period of 0.1 to 60 seconds, in 0.1 second increments
- 4) Control electronics shall report the following information per branch circuit:
 - a) Relay state (Open/Closed)
- 5) Built in Control shall include:
 - a) Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events
 - b) Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting relay state on each relay or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space.
 - c) Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet
 - d) Indication of an active preset shall be visible on the control panel display.
 - e) One 16-step sequence per space for power up and power down routines
 - f) The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included relays to "on", while setting non-emergency relays "off". Each relay can be selected for activation upon contact input.
 - g) Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority.
 - h) Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable.



- i) After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each relay change state.
- 6) The control of lighting and associated systems via real time and Astronomical clock controls.
 - a) The relay panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical timeclock.
 - b) System time events shall be programmable via the control panel.
 - (1) Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday.
 - (2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event.
 - (3) System shall automatically compensate for regions using a fully configurable daylight saving time.
 - (4) Presets shall be assigned to events at the time clock.
 - c) The time clock shall support event override
 - (1) It shall be possible to override the timed event schedule from the face panel of the time clock
 - d) The time clock shall support timed event hold
 - (1) It shall be possible to hold a timed event from the face panel of the processor
 - (2) Timed event hold shall meet California Title 24 requirements
- 7) The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any relay being patched to any DMX control address.
 - a) 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
 - b) The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.
 - c) Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel
 - d) DMX data loss shall allow for levels/relays to be held for ever or for a specified time before switching to a lower priority source
 - e) Initial Panel setup



- (1) The relay panel shall automatically detect the type of relay or dimmer installed in each location without need for manual configuration of the physical arrangement.
 - (2) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.
 - (3) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.
 - e. Relay Panel Accessories
 - 1) Ethernet Option shall provide advanced control of relays over streaming ACN (sACN) and transmit relay state, control override to web browser based interface or central monitoring interface
 - 2) A Low Voltage 0-10V Dimming Option shall link each of the 24 0-10V outputs with a relay circuit in the panel. Each output shall support up to 400mA of current sink for support of at least 50 LED drivers of fluorescent ballasts
 - 3) A Contact Input Option shall allow 24 dry contact inputs to be linked for direct or group relay control, to activate a preset, or to activate a sequence. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle.
 - 4) A DALI Control Option shall provide 24 control loops of broadcast DALI control with each loop controlling up to 64 ballasts. An external DALI loop power supply shall also be provided.
 - 5) A RideThru Option shall provide short-term power backup of control electronics by automatically engaging when power is lost, and recharging when normal power is present
 - 6) A Tamperproof Hardware Kit shall include center reject Torx head screws to prevent access to panel interior by unqualified individuals
 - 7) Main Breaker options shall be available as shown in Section G.2
 - f. Thermal
 - 1) The panel shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable
 - 2) The panel shall operate safely in an environment having an ambient temperature between 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).
8. Wall-Box Dimmers, Wall-Switch Occupancy Sensors, and Manual Light Switches:



- a. Provide wall-box dimmers, wall-switch occupancy sensors, and manual light switches complying with the requirements specified in Section 16140, Wiring Devices.
- 9. Conductors and Cables:
 - a. Power Wiring:
 - 1) Provide power wiring not smaller than 12AWG complying with the requirements specified in Section 16120, Conductors and Cables, but not smaller than 12AWG.
 - b. Class 1 Control Cables:
 - 1) Provide multiconductor Class 1 control cables complying with the requirements specified in Section 16120, Conductors and Cables, and having stranded-copper conductors not smaller than 14AWG.
 - c. Class 2 and Class 3 Control Cables:
 - 1) Provide multiconductor Class 2 and 3 control cables complying with the requirements specified in Section 16120, Conductors and Cables, and having stranded-copper conductors not smaller than 18AWG.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the locations to receive lighting control devices are ready for the Work of this Section.
 - a. Examine the locations to receive the lighting control devices.
 - b. Although the Contract Drawings are generally indicative of the Work, field-verify the actual conditions.
 - 1) Due to the small scale of the Contract Drawings it is not possible to indicate minor structural obstructions or relocations that may be encountered during the Work.
 - 2. Verify that electrical boxes and enclosures to be mated with the lighting control devices are the correct type and size, and are at the proper location.
- B. Evaluation and Assessment:
 - 1. Only begin the Work of this Section after the verification of conditions and the correction of non-conformances affecting the wiring devices have been completed.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the lighting control devices.



3.03 INSTALLATION

A. Installing Sensors:

1. Install sensors in locations and aim them so they achieve not less than 90 percent coverage of the areas indicated in the Contract Documents.
2. Do not exceed the coverage limits specified in the sensor manufacturer's written instructions.
 - a. Submit the sensor manufacturer's written instructions for the sensors to the Program/Project Manager for information.

B. Installing Contactors:

1. Unless the contactors are installed in an enclosure with factory-installed vibration isolators, mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration.

C. Installing Wiring:

1. Unless otherwise indicated, size the conductors for the lighting control devices according to the lighting control device manufacturer's written instructions.
 - a. Submit the lighting control device manufacturer's written instructions for sizing the conductors to the Program/Project Manager for information.
2. Wiring Method:
 - a. Provide wiring complying with the requirements specified in Section 16120, Conductors and Cables.
 - 1) Provide power wiring not smaller than 12AWG to the supply side of remote-control power sources.
 - b. Provide conduit complying with the requirements specified in Section 16130, Raceway and Boxes; and having a minimum size of 1/2 inch.
3. Wiring within Enclosures:
 - a. Provide wiring within enclosures complying with the requirements specified in ANSI/NECA 1.
 - b. Separate power-limited and nonpower-limited conductors according to the conductor manufacturer's written instructions.
 - 1) Submit the conductor manufacturer's written instructions for separating the conductors to the Program/Project Manager for information.
4. Splices, Taps, and Terminations:
 - a. Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Special Techniques:

1. Identification:
 - a. Identify lighting control devices in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Identify controlled circuits in the lighting contactors.



- 2) Identify the circuits or luminaries controlled by the occupancy sensors at each sensor.
 - b. Label time switches and contactors with a unique designation.
- E. Systems Integration:
 1. Wiring:
 - a. Install wiring and cable as indicated in Section 16120, Conductors and Cables.
 - b. Prior to the installation of any wire, verify that the conduit is clean and free of debris.
 2. Ground lighting control devices in conformance with Section 16060, Grounding and Bonding.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Operational Test:
 - a. Test Procedure:
 - 1) After installing the time switches and sensors, and after electrical circuitry has been energized, test the time switches and sensors for compliance with specified requirements
 - 2) Prepare field quality-control test reports to document the test results, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Lighting control devices that fail tests and inspections are considered to be defective, non-conforming work.
 2. Inspections:
 - a. After installing the time switches and sensors, and after electrical circuitry has been energized, inspect the time switches and sensors for compliance with specified requirements.
- B. Non-Conforming Work
 1. When Work is determined to be non-conforming, correct circuit conditions, remove malfunctioning units and replace the malfunctioning units with new ones, and retest the devices as specified herein.

3.05 SYSTEM STARTUP

- A. After installing time switches and sensors, and after electrical circuitry has been energized, adjust the time switches and sensors to comply with the specified requirements.
 1. Verify operation of each lighting control device, and adjust the time delays.

3.06 ADJUSTING

- A. Occupancy Adjustments:



1. When requested within 12 months of the date of Substantial Completion, provide on-site assistance to adjust the sensors to suit occupied conditions.
2. Provide up to 2 visits to the Site during other-than-normal occupancy hours for this purpose.

3.07 CLOSEOUT ACTIVITIES

A. Training:

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the lighting control devices in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.08 PROTECTION

A. Take steps to ensure that lighting control devices and their boxes are protected during construction activities.

1. Do not place wall finish materials over device boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3.09 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the lighting control devices for inclusion in the emergency and operation and maintenance manuals.
 - a. Submit the operation and maintenance data for the lighting control devices to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	04/06/2018	N/A	1.02.C.6, 2.01.D.2	Corrected web addresses





SECTION 16234

DIESEL ELECTRIC GENERATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for packaged engine-generator sets for supplying emergency power, and that have the following features:
 - a. Diesel engine.
 - b. Unit-mounted cooling system.
 - c. Unit-mounted control and monitoring.
 - d. Performance enhancements for sensitive loads.
 - e. Load banks.
 - f. Outdoor enclosure.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 03100 - Concrete Forms and Accessories.
 - 6. Section 03200 - Concrete Reinforcement.
 - 7. Section 03300 - Cast-In-Place Concrete.
 - 8. Section 07720 - Roof Accessories.
 - 9. Section 13453 - Supervisory Control and Data Acquisition (SCADA).
 - 10. Section 15065 - Motors for Mechanical Equipment.
 - 11. Section 15075 - Mechanical Identification.
 - 12. Section 15182 - Hydronic Piping.
 - 13. Section 16061 - Electrical Grounding and Bonding.
 - 14. Section 16070 - Hangers and Supports.
 - 15. Section 16075 - Electrical Identification.
 - 16. Section 16120 - Conductors and Cables.
 - 17. Section 16497 - Automatic Transfer Switches.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. dBA: Decibels, referenced to the A-weighting filter curve defined in IEC 61672.
 - 3. CA: Commissioning Authority.
 - 4. DC: Direct electrical current.
 - 5. GFCI: Ground-fault circuit interrupter.



6. HVAC: Heating, Ventilating, and Air-Conditioning.
7. LED: Light emitting diode.
8. LP: Liquid petroleum.
9. SCADA: Supervisory control and data acquisition.
10. w. g.: Water gauge.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
3. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

C. Reference Standards:

1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. The Association for Manufacturing Technology (AMT):
 - a. AMT B15.1 – Safety Standards for Mechanical Power Transmission Apparatus.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 115 – IEEE Guide: Test Procedures for Synchronous Machines.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
7. International Electrotechnical Commission (IEC):
 - a. IEC 61672 – Electroacoustics – Sound Level Meters – Part 2: Pattern Evaluation Tests.
8. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).



- b. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- c. NEMA MG 1 – Motors and Generators.
- 9. National Institute of Standards and Technology (NIST):
 - a. Standards Services Division,
<http://ts.nist.gov/standards/accreditation/index.cfm>:
- 10. National Fire Protection Association (NFPA):
 - a. NFPA 30 – Flammable and Combustible Liquids Code.
 - b. NFPA 37 – Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - c. NFPA 70 – National Electrical Code® (NEC).
 - d. NFPA 99 – Health Care Facilities Code.
 - e. NFPA 110 - Standard for Emergency and Standby Power Systems.
- 11. National Institute for Certification in Engineering Technologies (NICET),
www.nicet.org:
 - a. Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
- 12. Underwriters Laboratories, Inc. (UL):
 - a. UL 142 - Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
 - b. UL 1236 – Standard for Battery Chargers for Charging Engine-Starter Batteries.
 - c. UL 2200 - Standard for Stationary Engine Generator Assemblies.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, the Commissioning Authority, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. Coordinate the size and location of concrete bases for the packaged engine generators.
 - 3. Coordinate the size and location of roof curbs, equipment supports, and roof penetrations for remote radiators.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Diesel electric generators.
 - b. Shop Drawings:



- 1) Diesel electric generator outline plan and elevation drawings..
 - 2) Vibration isolation base details.
 - 3) Wiring diagrams for the diesel electric generators.
 - c. Delegated Design Submittals:
 - 1) Design Calculations.
 - d. Qualification Statements:
 - 1) Diesel electric generator installer's qualifications.
 - 2) Diesel electric generator manufacturer's qualifications.
 - 3) Testing Agency's qualifications.
 - 4) Professional Engineer's credentials.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Packaged engine generator manufacturers' written installation and alignment instructions.
 - b. Source Quality Control Submittals:
 - 1) Summary of the Prototype-Unit Test.
 - 2) Certified Test Reports for equivalent components and accessories.
 - 3) Certified Summary of Performance Tests.
 - 4) Certification of Torsional Vibration Compatibility.
 - c. Site Quality Control Submittals:
 - 1) Field Quality-Control Report for the NETA Acceptance Testing.
 - 2) Field Quality-Control Report for the NFPA 110 Acceptance Test.
 - 3) Field Quality-Control Report for the Battery Tests.
 - 4) Field Quality-Control Report for the Battery-Charger Tests.
 - 5) Field Quality-Control Report for the System Integrity Tests.
 - 6) Field Quality-Control Report for the Exhaust-System Back-Pressure Test.
 - 7) Field Quality-Control Report for the Exhaust Emissions Test.
 - 8) Field Quality-Control Report for the Voltage and Frequency Transient Stability Tests.
 - 9) Field Quality-Control Report for the Harmonic-Content Tests.
 - 10) Field Quality-Control Report for the Noise Level Tests.
 - 11) Field Quality-Control Report for the Leak Test.
 - 12) Field Quality-Control Report for the Operational Test.
 - 13) Field Quality-Control Report for the Infrared Scanning.
 - 14) Calibration record for the infrared scanning device.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Maintenance Contracts:



- 1) Diesel Electric Generator Maintenance Service Agreement.
 - b. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the packaged engine generators and accessories.
 - c. Warranty Documentation:
 - 1) Packaged Engine Generator Warranty.
- D. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare interior lighting products that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Fuses:
 - (1) For each type and rating of fuse installed, furnish 1 spare fuse for every 10 fuses installed, but not less than one of each type and rating.
 - b) Indicator Lamps:
 - (1) For each type of indicator lamp installed, furnish 2 spare indicator lamps for every 6 indicator lamps installed, but not less than 2 of each type.
 - c) Filters:
 - (1) Furnish one spare set each of the lubricating oil, fuel, and combustion-air filters for the diesel electric generators.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of diesel electric generators and accessories.
 - 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ



both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Diesel Electric Generator Installer's Qualifications:
 - a. To install the diesel electric generators, employ a manufacturer's authorized representative trained and approved for installation of the units provided under this Contract.
 - b. Maintenance Proximity:
 - 1) The installer's place of business must not be located more than 4 hours' normal travel time from the Site.
 - c. Submit the diesel electric generator installer's qualifications to the Program/Project Manager for approval.
2. Diesel Electric Generator Manufacturer's Qualifications:
 - a. Procure products from a qualified manufacturer.
 - b. Procure products from a manufacturer that maintains a service center, within 200 miles (321km) of the Site, capable of providing training, parts, and emergency maintenance repairs.
 - c. Submit the diesel electric generator manufacturer's qualifications to the Program/Project Manager for approval.
3. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with the requirements specified in ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET) in accordance with the requirements specified in the Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.
4. Professional Engineer's Qualifications:
 - a. Engage a qualified Professional Engineer registered in the State of Arizona to perform vibration isolation analysis required for the diesel electric generator systems.
 - b. Submit the Professional Engineer's credentials to the Program/Project Manager for information.



C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide electrical components, devices, and accessories that are listed and labeled for the location the product is installed in, and the application intended, by a Nationally Recognized Testing Laboratory (NRTL), as defined in Article 100 of NFPA 70, acceptable to the Authorities Having Jurisdiction (AHJ), unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.

B. Storage and Handling Requirements:

1. Store and handle products in a manner that will prevent material damage and deterioration or contamination from the elements.

C. Packaging Waste Management:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. Remove loose packing and flammable materials from inside the diesel electric generators.
3. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:



1. Provide an engine-generator system capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of performance:
 - a. Ambient Temperature:
 - 1) Provide an engine-generator system capable of operating within the range 5 degrees Celsius to 40 degrees Celsius.
 - b. Altitude:
 - 1) Provide an engine-generator system capable of operating from sea level up to 3000 feet (1000m) above sea level.
- B. Existing Conditions:
 1. Interruption of Existing Electric Service:
 - a. Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electric service according to the requirements indicated:
 - 1) Notify the Program/Project Manager no fewer than 2 weeks in advance of the proposed interruption of electric service.
 - 2) Do not interrupt electric service without the Program/Project Manager's written permission.

1.08 WARRANTY

- A. Manufacturer Warranty:
 1. Packaged Engine Generator Warranty:
 - a. Warrant the packaged engine generators against defects within the 5-year period after the Date of Substantial Completion:
 - 1) Submit a Packaged Engine Generator Warranty on the packaged engine generator manufacturer's standard form, without monetary limitation, in which the packaged engine generator manufacturer agrees to repair or replace packaged engine generators and associated auxiliary components that fail in materials or workmanship within the specified warranty period to include parts, labor, and mileage to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 DIESEL ELECTRIC GENERATOR ASSEMBLIES

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide the Basis-of-Design product indicated on the Contract Drawings or a comparable product manufactured by one of the manufacturers listed.
 - b. Manufacturers:
 - 1) Caterpillar; Engine Division, <http://www.cat.com/engines>



- 2) Generac Power Systems, Inc., <http://www.generac.com>.
- 3) Onan/Cummins Power Generation; Industrial Business Group, <https://power.cummins.com/>.
- 4) Approved equal.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain each diesel electric generator and associated components from a single source and single manufacturer.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for diesel electric generators in NFPA 70.
 - c. Engine Exhaust Emissions:
 - 1) Comply with the applicable state and local government requirements regulating engine exhaust emissions.
 - d. Noise Emission:
 - 1) Provide products and installation complying with the applicable state and local government requirements for maximum noise level at the facility due to sound emitted by generator sets, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
 - e. Fuel Oil Storage:
 - 1) Comply with fuel oil storage containment requirements of the Authorities Having Jurisdiction.
- C. Performance:
 1. Capacities and Characteristics:
 - a. Power Output Ratings:
 - 1) Provide diesel electric generators having the nominal ratings indicated in the Contract Documents, and having the capability to operate as a unit as evidenced by the records of the prototype testing required under this Section.
 - b. Output Connections:
 - 1) Provide diesel electric generators having three-phase, four wire output connections.
 2. Generator-Set Performance:



- a. Steady-State Voltage Operational Bandwidth:
 - 1) Provide diesel electric generators having a steady-state voltage operational bandwidth of 3 percent of the rated output voltage from no load to full load.
 - b. Transient Voltage Performance:
 - 1) Provide diesel electric generators having not more than a 20 percent variation in transient voltage for a 50 percent step-load increase or decrease.
 - a) The voltage must recover and remain within the steady-state operating band within 3 seconds.
 - c. Steady-State Frequency Operational Bandwidth:
 - 1) Provide diesel electric generators having a steady-state frequency operational bandwidth of 0.5 percent of the rated frequency from no load to full load.
 - d. Steady-State Frequency Stability:
 - 1) Provide diesel electric generators having no random speed variations outside the steady-state operational band, and no hunting or surging of speed, when the system is operating at any constant load within the rated load.
 - e. Transient Frequency Performance:
 - 1) Provide diesel electric generators having less than a 5 percent variation in transient frequency for a 50 percent step-load increase or decrease.
 - a) The frequency must recover and remain within the steady-state operating band within 5 seconds.
 - f. Output Waveform:
 - 1) Provide diesel electric generators having harmonic waveform output content, measured line to line or line to neutral, not exceeding 5 percent in total or 3 percent for single harmonics, at no load.
 - 2) Provide diesel electric generators having a telephone influence factor not exceeding 50 percent when determined in accordance with the method specified in NEMA MG 1.
 - g. Sustained Short-Circuit Current:
 - 1) For a 3-phase, bolted short circuit at the system output terminals, provide diesel electric generator systems supplying a minimum of 250 percent of the rated full-load current for not less than 10 seconds, and then clear the fault automatically, without damage to the generator system components.
 - h. Start Time:
 - 1) Provide diesel electric generators having start times complying with the system requirements for Type 10 systems specified in NFPA 110.
3. Generator-Set Performance for Sensitive Loads:



- a. Oversizing the generator compared with the rated power output of the engine is permissible to provide the specified performance.
 - 1) Nameplate Data for Oversized Generator:
 - a) Provide nameplate data for oversized generators showing the ratings required by the Contract Documents rather than the ratings that would normally be applied to the size generator installed.
- b. Steady-State Voltage Operational Bandwidth:
 - 1) Provide diesel electric generators having a steady-state voltage operational bandwidth of 1 percent of the rated output voltage from no load to full load.
- c. Transient Voltage Performance:
 - 1) Provide diesel electric generators having not more than a 10 percent variation in transient voltage for a 50 percent step-load increase or decrease.
 - a) The voltage must recover and remain within the steady-state operating band within 0.5 second.
- d. Steady-State Frequency Operational Bandwidth:
 - 1) Provide diesel electric generators having a steady-state frequency operational bandwidth of plus or minus 0.25 percent of the rated frequency from no load to full load.
- e. Steady-State Frequency Stability:
 - 1) Provide diesel electric generators having no random speed variations outside the steady-state operational band, and no hunting or surging of speed, when the system is operating at any constant load within the rated load.
- f. Transient Frequency Performance:
 - 1) Provide diesel electric generators having less than a 2-Hertz variation in transient frequency for a 50 percent step-load increase or decrease.
 - a) The frequency must recover and remain within the steady-state operating band within 3 seconds.
- g. Output Waveform:
 - 1) Provide diesel electric generators having harmonic waveform output content, measured line to neutral, not exceeding 2 percent in total with no slot ripple, at no load.
 - 2) Provide diesel electric generators having a telephone influence factor not exceeding 50 percent when determined in accordance with the method specified in NEMA MG 1.
- h. Sustained Short-Circuit Current:
 - 1) For a 3-phase, bolted short circuit at the system output terminals, provide diesel electric generator systems supplying a minimum of 300 percent of the rated full-load current for not less than 10 seconds, and then clear the fault automatically, without damage to the winding insulation or other system components.



- i. Excitation System:
 - 1) Provide diesel electric generators having performance that is unaffected by voltage distortion caused by nonlinear loads.
 - a) Provide permanent magnet excitation for the power source to the voltage regulator.
 - a. Start Time:
 - 1) Provide diesel electric generators having start times complying with the system requirements for Type 10 systems specified in NFPA 110.
- D. Design Criteria:
- 1. Provide factory-assembled and factory-tested diesel electric generators complying with the requirements specified in AMT B15.1, NFPA 37, and UL 2200.
 - 2. Provide diesel electric generators complying with the requirements for Level 1 emergency power supply systems specified in NFPA 110.
 - 3. Locate the packaged engine generators so access for periodic maintenance is provided, without having to remove connections or accessories.
 - a. Maintain the minimum clearances and workspace at the equipment in accordance with the manufacturer's written instructions and the requirements specified in NFPA 70.
 - 4. Vibration Isolation Design:
 - a. Employ a qualified Professional Engineer to prepare data for vibration isolators for engine skid mounts; and to design vibration isolation complying with the performance requirements and design criteria signed and sealed by the Professional Engineer responsible for their preparation.
 - 1) Vibration Isolation Base Details:
 - a) Have the Professional Engineer detail the fabrication, of the anchorages and attachments to the structure and to the supported equipment, including preparing Shop Drawings signed and sealed by the Professional Engineer responsible for their preparation.
 - (1) Include setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices.
 - (2) Include base weights.
 - 2) Design Calculations:
 - a) Have the Professional Engineer calculate the requirements for selecting vibration isolators, including preparing comprehensive analysis data based on testing and engineering analysis of the manufacturer's standard units in assemblies similar to those to be provided under this Contract and signed and sealed by the Professional Engineer



- responsible for their preparation, and design the vibration isolation bases.
 - b. Submit the signed and sealed fabrication details and design calculations to the Program/Project Manager for approval.
- 5. Piping Systems:
 - a. Plans, schematics, and diagrams included in the Contract Drawings indicate the general location and arrangement of piping systems.
 - 1) The indicated locations and arrangements were used to size pipe, calculate friction losses, and for compliance with other design considerations.
 - 2) Install piping as indicated unless deviations to the layout are approved by the Program/Project Manager.
- 6. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of packaged engine generator specified.
 - 1) Include the diesel electric generator's rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2) Include the Thermal damage curve for generator.
 - 3) Include the Time-current characteristic curves for generator protective device.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- 7. Shop Drawings:
 - a. Prepare Shop Drawings for the diesel electric generators that detail equipment assemblies and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1) Furnish a dimensioned outline plan and elevation drawings of the engine-generator set and other components specified.
 - b. Wiring Diagrams:
 - 1) Furnish power, signal, and control wiring diagrams for the diesel electric generators.
 - c. Submit the Shop Drawings and wiring diagrams to the Program/Project Manager for approval.
- E. Operation:
 - 1. Controls:
 - a. Configuration:
 - 1) Group the operating and safety indications, protective devices, basic system controls, and engine gages in a common control and monitoring panel mounted on the generator set.
 - a) Use mounting method that isolate the control panel from generator-set vibration.
 - b. Indicating and Protective Devices and Controls:



- 1) Provide the indicating and protective devices and controls required for a Level 1 system as specified in NFPA 110 and as follow:
 - a) AC voltmeter.
 - b) AC ammeter.
 - c) AC frequency meter.
 - d) DC voltmeter (alternator battery charging).
 - e) Engine-coolant temperature gage.
 - f) Engine lubricating-oil pressure gage.
 - g) Running-time meter.
 - h) Ammeter-voltmeter, phase-selector switch(es).
 - i) Generator-voltage adjusting rheostat.
 - j) Fuel tank derangement alarm.
 - k) Fuel tank high-level shutdown of fuel supply alarm.
 - l) Generator overload.
- c. Supporting Devices:
 - 1) Provide the sensors, transducers, terminals, relays, and other devices necessary to support the operation of the diesel electric generators, and include the wiring required to support the specified items.
 - 2) Unless otherwise indicated in the Contract Documents, locate the sensors and other supporting items on the engine or generator.
- d. Connection to Data Link:
 - 1) For each alarm and status indication, provide connections for data-link transmission of indications to remote data terminals.
 - 2) Data system connections to terminals are specified in Section 13453, Supervisory Control and Data Acquisition (SCADA).
 - 3) Data system shall connect to Airport existing Honey-Well remote generator monitoring system.
- e. Common Remote Audible Alarm:
 - 1) Provide a common remote audible alarm complying with the requirements for Level 1 systems specified in NFPA 110, and include the following necessary contacts and terminals in the control and monitoring panel:
 - a) Overcrank shutdown.
 - b) Coolant low-temperature alarm.
 - c) Control switch not in auto position.
 - d) Battery-charger malfunction alarm.
 - e) Battery low-voltage alarm.
- f. Remote Alarm Annunciator:
 - 1) Provide a remote alarm annunciator complying with the requirements specified in NFPA 99.



- 2) Provide an LED labeled with the proper alarm conditions to identify each alarm event, and provide a common audible signal that will sound for each alarm condition.
- 3) Provide a silencing switch in the face of the panel that silences the signal without altering the visual indication.
- 4) Connect the remote alarm annunciator so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
- 5) Provide a surface- mounting or flush-mounting type cabinet and faceplate to suit the mounting conditions indicated in the Contract Documents.
- g. Remote Emergency-Stop Switch:
 - 1) Unless otherwise indicated in the Contract Documents, provide a flush, wall mounted, and labeled remote emergency-stop switch.
 - 2) Provide protection for the push button so it cannot be accidentally operated.
2. Operation Sequences:
 - a. Automatic Starting System Sequence of Operation:
 - 1) When the mode-selector switch on the control and monitoring panel is in the automatic position, the remote-control contacts in one or more separate automatic transfer switches must initiate the starting and stopping of the generator set.
 - a) When the mode-selector switch is switched to the on position, the generator set must start.
 - b) The off position of same switch must initiate generator-set shutdown.
 - c) When the generator set is running, specified system or equipment failures or derangements must automatically shut down the generator set and initiate alarms.
 - d) Operation of a remote emergency-stop switch must also shut down the generator set.

F. Components:

1. Mounting Frame:
 - a. Provide mounting frames that maintain the alignment of mounted components without depending on the concrete foundation, and that have lifting attachments.
 - b. Rigging Diagram:
 - 1) Provide a rigging diagram inscribed on a metal plate permanently attached to the mounting frame to indicate the location and lifting capacity of each lifting attachment and the generator-set center of gravity.
2. Engine:
 - a. Fuel:
 - 1) Provide an engine capable of running on Grade DF-2 fuel oil.
 - b. Rated Engine Speed:



- 1) Provide an engine rated for an engine speed of 1800 revolutions per minute.
- c. Maximum Piston Speed:
 - 1) Provide a four-cycle engine having a maximum piston speed of 2250 feet per minute (11.4m/s).
- d. Engine Lubrication System:
 - 1) Provide a lubrication system for the engine having the following items mounted on the engine or skid:
 - a) Filter and Strainer:
 - (1) Provide filter and strainer rated for removal of 90 percent of particles 5 micrometers and smaller while passing full flow.
 - b) Thermostatic Control Valve:
 - (1) Provide a thermostatic control valve designed to control the flow in the system in order to maintain the optimum oil temperature.
 - (a) Provide a thermostatic control valve capable accommodating the full flow, and designed to be fail-safe.
 - c) Crankcase Drain:
 - (1) Provide a crankcase drain arranged for complete gravity drainage of the crankcase to an easily removable container with no disassembly, and without the need for pumps, siphons, special tools, or appliances.
 - e. Engine Fuel System:
 - 1) Main Fuel Pump:
 - a) Provide a main fuel pump, mounted on the engine, that ensures adequate primary fuel flow under starting and load conditions.
 - 2) Relief-Bypass Valve:
 - a) Provide a relief-bypass valve that automatically regulates the pressure in the fuel line and returns excess fuel to source.
 - f. Coolant Jacket Heater:
 - 1) Provide an electric-immersion type coolant jacket heater complying with the requirements for Level 1 equipment specified in NFPA 110 for the heater capacity, and factory-installed in the coolant jacket system.
 - g. Governor:
 - 1) Provide an adjustable isochronous governor having speed sensing.
 - h. Cooling System:
 - 1) Provide a closed loop, liquid cooled cooling system having a radiator factory-mounted on the engine-generator-set mounting frame and an integral engine-driven coolant pump.
 - a) Coolant:



- (1) Provide system coolant consisting of a solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by the engine manufacturer.
- b) Size of Radiator:
 - (1) Provide a radiator sized adequately to contain the expansion of the total system coolant from a cold start to a 110 percent load condition.
- c) Temperature Control:
 - (1) Provide a self-contained, thermostatic-control valve that modulates the coolant flow automatically to maintain the optimum constant coolant temperature recommended by the engine manufacturer.
- d) Coolant Hose:
 - (1) Provide a flexible coolant hose assembly having an inside surface of nonporous rubber and an outer covering of aging- resistant, ultraviolet- resistant, and abrasion-resistant fabric.
 - (2) Rating:
 - (a) Provide a cooling system rated for a maximum working pressure of 50 psig (345kPa) with the coolant at 180 degrees Fahrenheit (82 degrees Celsius), and that is noncollapsible under a vacuum.
 - (3) End Fittings:
 - (a) Provide flanges or steel pipe nipples having clamps to suit the piping and equipment connections.
- i. Muffler/Silencer:
 - 1) Provide a critical type muffler/silencer, sized as recommended by the engine manufacturer, and selected so the exhaust piping system does not exceed the engine manufacturer's engine backpressure requirements.
 - a) Provide a muffler/silencer providing sound attenuation of at least 12 decibels at 500 Hertz.
 - b) Provide a muffler/silencer providing a sound level measured at a distance of 10 feet (3m) from the exhaust discharge after installation is complete of 85 dBA or less.
- j. Air-Intake Filter:
 - 1) Provide a heavy-duty, engine-mounted air cleaner having a replaceable dry-filter element and a "blocked filter" indicator.
- k. Starting System:
 - 1) Provide a 24-Volt electric starting system having a negative ground.
 - a) Components:
 - (1) Provide starting system components sized so they will not be damaged during a full engine-cranking cycle at the



maximum ambient temperature specified in Subparagraph 1.07.A.1.a.1.

- b) Cranking Motor:
 - (1) Provide a heavy-duty cranking motor unit that automatically engages and releases from the engine flywheel without binding.
- c) Cranking Cycle:
 - (1) Provide the cranking cycle complying with the requirements specified in NFPA 110 for the system level.
- d) Battery:
 - (1) Provide a battery having adequate capacity within ambient temperature range specified in Subparagraph 1.07.A.1.a.1 to provide the specified cranking cycle at least twice without recharging.
- e) Battery Cable:
 - (1) Provide a battery cable sized as recommended by the engine manufacturer for the cable length indicated.
 - (a) Include the required interconnecting conductors and connection accessories.
- f) Battery Compartment:
 - (1) Provide a factory-fabricated battery compartment made from metal having an acid-resistant finish and thermal insulation.
 - (a) Include the accessories required to support and fasten the batteries in place.
- g) Battery-Charging Alternator:
 - (1) Provide a factory-mounted battery-charging alternator on the engine having solid-state voltage regulation and a minimum continuous rating of 35 Amperes.
- h) Battery Charger:
 - (1) Provide a current-limiting, automatic-equalizing and float-charging type battery charger, complying with the requirements specified in UL 1236, and that includes the following features:
 - (a) Operation:
 - i. Provide a battery charger providing an equalizing-charging rate of 10 Amperes initiated automatically after the battery has lost charge until an adjustable equalizing voltage is achieved at the battery terminals.
 - ii. Include provisions that, once an equalizing voltage is achieved at the battery terminals, then automatically switch the unit to a lower float-charging mode and continue its operation in that mode until the battery is discharged again.



- (b) Automatic Temperature Compensation:
 - i. Provide a battery charger that adjusts float and equalize voltages for variations in ambient temperature from minus 40 degrees Celsius to plus 60 degrees Celsius to prevent overcharging at high temperatures and undercharging at low temperatures.
 - (c) Automatic Voltage Regulation:
 - i. Provide a battery charger that maintains constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - (d) Ammeter and Voltmeter:
 - i. Provide a battery charger that has an ammeter and a voltmeter flush-mounted in the door.
 - ii. Provide meters that indicate the charging rates.
 - (e) Safety Functions:
 - i. Provide a battery charger capable of sensing abnormally low battery voltage and of closing contacts providing a low battery voltage indication on the control and monitoring panel.
 - ii. Provide a battery charger capable of sensing high battery voltage and the loss of the AC input or the DC output of the battery charger.
 - iii. Provide a battery charger capable under either condition of closing contacts that provide a battery-charger malfunction indication at the system control and monitoring panel.
 - (f) Enclosure and Mounting:
 - i. Provide a factory mounted cabinet complying with the requirements for a NEMA Type 1 enclosure specified in NEMA 250 for the battery charger.
- 3. Fuel Oil Storage:
 - a. Provide storage for fuel oil complying with the requirements specified in NFPA 30.
 - b. Base-Mounted Fuel Oil Tanks:
 - 1) Provide factory-installed and factory-piped base-mounted fuel oil tanks complying with the requirements specified in UL 142, and having the following features:
 - a) Tank Level Indicators:
 - (1) Provide fuel oil tanks having tank level indicators.
 - b) Capacity:
 - (1) Provide fuel oil tanks capable of holding fuel for 24 hours' continuous operation at 100 percent of the rated power output of the generator.
 - c) Fill Cap:



- (1) Provide vandal-resistant fill caps.
 - d) Monitoring. Provide fuel level monitoring through Aviation Veeder-Root monitoring system including low, low-low, and high alarms.
- 4. Generator Overcurrent and Fault Protection:
 - a. Generator Disconnect Switch:
 - 1) Provide a 100 percent rated molded-case type disconnect switch.
 - a) Rating:
 - (1) Provide the disconnect switch rating matched to the generator output rating.
 - b) Shunt Trip:
 - (1) Provide a shunt trip connected to the trip switch when signaled by the generator protector or by other protective devices.
 - b. Generator Protector:
 - 1) Provide a microprocessor-based generator protector unit that continuously monitors the current level in each phase of the generator output, integrates the generator heating effect over time, and predicts when thermal damage of the alternator will occur.
 - a) When signaled by the generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch must open the switch to disconnect the generator from load circuits.
 - 2) Provide a generator protector that performs the following functions:
 - a) Provide a generator protector that initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds.
 - (1) Integrate the indication for this alarm with other generator-set malfunction alarms.
 - b) Provide a generator protector that, under single or three-phase fault conditions, regulates the generator to 300 percent of the rated full-load current for up to 10 seconds.
 - c) Provide a generator protector that, as the overcurrent heating effect on the generator approaches the thermal damage point of the unit, switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 - d) Provide a generator protector that senses the clearing of a fault by other overcurrent devices, and controls the recovery of the rated voltage to avoid overshoot.
 - 3) Ground-Fault Indication:



- a) Provide ground-fault indication that complies with the requirements for "Emergency System" signals for ground-fault specified in NFPA 70.
 - (1) Integrate the ground-fault alarm indication with other generator-set alarm indications.
- 5. Generator, Exciter, and Voltage Regulator:
 - a. Provide generator, exciter, and voltage regulator that complies with the requirements specified in NEMA MG 1.
 - b. Drive:
 - 1) Provide a generator drive shaft directly connected to the engine shaft.
 - 2) Provide a generator drive that rotates the exciter integrally with the generator rotor.
 - c. Electrical Insulation:
 - 1) Provide Class H or Class F electrical insulation.
 - d. Stator-Winding Leads:
 - 1) Provide stator-winding leads brought to the terminal box to permit future reconnection for other voltages if required.
 - e. Provide a generator, exciter, and voltage regulator designed and constructed to prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of the generator rating, and heat during operation at 110 percent of the rated capacity.
 - f. Enclosure:
 - 1) Provide a drip proof enclosure for the generator, exciter, and voltage regulator.
 - g. Instrument Transformers:
 - 1) Provide instrument transformers mounted within the generator enclosure.
 - h. Voltage Regulator:
 - 1) Provide a solid-state type voltage regulator, separate from the exciter, that provides the performance specified in this Section.
 - 2) Provide an adjusting rheostat on the control and monitoring panel capable of providing a plus or minus 5 percent adjustment of the output-voltage operating band.
 - i. Windings:
 - 1) Provide a two-thirds pitch stator winding and a fully linked amortisseur winding.
 - j. Subtransient Reactance:
 - 1) Provide a generator, exciter, and voltage regulator having a maximum Subtransient reactance of 12 percent.
- 6. Load Bank:
 - a. Provide permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive load bank units capable of providing a balanced 3-phase, delta-connected load to the generator set at 80 percent of the



rated-system capacity, when operating with an 80 percent lagging power factor.

- 1) The load bank unit may be composed of separate resistive load banks controlled by a common control panel.
- 2) The load bank unit must be capable of selective control of the load in 25 percent steps, and with minimum step changes of approximately 5 and 10 percent of the load available.
- b. Resistive Load Elements:
 - 1) Provide double insulated corrosion-resistant chromium alloy resistive load elements having ceramic and steel supports, and designed for repetitive on-off cycling.
 - a) Mount the elements in removable aluminized-steel heater cases.
- c. Load-Bank Heat Dissipation:
 - 1) Provide integral fans having totally enclosed motor that provide a uniform cooling airflow through the load elements.
 - a) Provide airflow and coil operating current so, at the maximum load and with the ambient temperature at the upper end of specified range, the load-bank elements operate at not more than 50 percent of the maximum continuous temperature rating of the resistance elements.
- d. Load Element Switching:
 - 1) Provide remote-controlled contactors to switch groups of load elements.
 - a) Provide contactor coils rated at 120 Volts.
 - b) Locate the contactors in a separate enclosure complying with the requirements for NEMA Type 3R enclosures specified in NEMA 250, within the load-bank enclosure and accessible from the exterior through hinged doors having tumbler locks.
- e. Contactor Enclosures:
 - 1) Provide contactor enclosures that are heated by thermostatically controlled strip heaters to prevent condensation.
- f. Load-Bank Enclosures:
 - 1) Provide load-bank enclosures complying with the requirements for NEMA Type 3R enclosures specified in NEMA 250, and with the requirements specified in NEMA ICS 6.
 - 2) Provide load-bank enclosures having louvers at the cooling-air intake and discharge openings that prevent the entry of rain and snow.
 - 3) Provide screens having 1/2-inch (13mm) square, galvanized-steel mesh at the airflow openings.
- g. Protective Devices:
 - a) Provide fuses for the power input circuits to the load banks selected to coordinate with the generator circuit breaker.
 - (1) Locate the fuse blocks in the contactor enclosure.



- (2) Provide cooling airflow and overtemperature sensors that automatically shut down and lock out the load bank until they are manually reset.
 - (3) Provide safety interlocks on access panels and doors that disconnect the load power, control, and heater circuits.
 - (4) Provide fan motors that are separately protected by overload and short-circuit devices.
 - (5) Provide short-circuit devices consisting of noninterchangeable fuses having a 200,000-Ampere interrupting capacity.
 - 2) Remote-Control Panels:
 - a) Provide remote-control panels that are separate from the load bank in enclosures complying with the requirements for NEMA Type 3 enclosures specified in NEMA 250 having a control power switch and pilot light, and switches controlling groups of load elements.
 - 3) Control Sequence:
 - a) Control panels may be preset for adjustable single-step loading of the generator during automatic exercising.
- h. Outdoor Generator-Set Enclosure:
 - 1) Provide vandal-resistant, weatherproof steel housings that are wind resistant up to 100 miles per hour (160km/h).
 - a) Where multiple panels are provided, they must be lockable and provide adequate access to the components requiring maintenance.
 - b) Provide panels that are removable by one person without tools.
 - c) Mount the instruments and controls within the enclosures.
- i. Engine Cooling Airflow through Enclosure:
 - 1) Provide a cooling airflow through the enclosure to maintain the temperature rise of system components within the required limits when the unit operates at 110 percent of the rated load for 2 hours with the ambient temperature at the top of the range specified in the system service conditions.
 - a) Louvers:
 - (1) Provide louvers for the fixed-engine, cooling-air inlet and discharge.
 - (2) Provide stormproof and drainable louvers that prevent the entry of rain and snow.
 - b) Automatic Dampers:
 - (1) Provide automatic dampers at the engine cooling-air inlet and discharge.
 - (2) Provide dampers that can be closed to reduce the enclosure heat loss in cold weather when the unit is not operating.



- j. Interior Lights with Switch:
 - 1) Provide factory-wired, vapor proof-type interior light fixtures arranged within the housing to illuminate the controls and the accessible interior, and arranged to allow for external electrical connections.
 - a) When a remote source is available for operation, provide an alternating electric current (AC) lighting system and connection point.
 - b) When a remote source and generator are both unavailable for operation, provide a direct electrical current (DC) lighting system.
- k. Convenience Outlets:
 - 1) Provide factory-wired, ground-fault circuit interrupter convenience outlets arranged for external electrical connection.
- 7. Motors:
 - a. Provide motors complying with the requirements specified in Section 15065, Motors for Mechanical Equipment.
 - 1) Motor Sizes:
 - a) Provide the minimum size as indicated in the Contract Documents.
 - (1) If the motor sizes are not indicated, provide motors large enough so the driven load will not require the motor to operate in a service factor range above 1.0.
 - 2) Controllers, Electrical Devices, and Wiring:
 - a) Provide motor controllers, electrical devices, and connections as specified in other Sections.
- 8. Vibration Isolation Devices:
 - a. Elastomeric Isolator Pads:
 - 1) Provide oil-resistant and water-resistant natural rubber vibration isolator pads, arranged in 2 layers, molded with a nonslip pattern, and having galvanized-steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
 - a) Provide natural rubber having a durometer rating of 50.
 - b) Provide elastomeric isolator pads having a minimum deflection of 1 inch (25mm).
 - 2) Factory-cut the vibration isolator pads to sizes that match the requirements of the supported equipment.
 - b. Restrained Spring Isolators:
 - 1) Provide freestanding, steel, open-spring isolators having seismic restraints.
 - a) Housings:
 - (1) Provide steel housings having resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed, factory-drilled baseplates bonded to 1/4 inch (6mm) thick elastomeric isolator pads attached to the



underside of the baseplates, and adjustable equipment mounting and leveling bolts that act as blocking during installation.

- b) Outside Spring Diameters:
 - (1) Provide outside spring having diameters not less than 80 percent of the compressed height of the spring at the rated load.
 - c) Minimum Additional Travel:
 - (1) Provide restrained spring isolators capable of additional travel equal to at least 50 percent of the required deflection at the rated load.
 - d) Lateral Stiffness:
 - (1) Provide restrained spring isolators having more than 80 percent of the rated vertical stiffness.
 - e) Overload Capacity:
 - (1) Provide restrained spring isolators capable of supporting 200 percent of the rated load without deformation or failure when fully compressed.
9. Nameplates:
- a. For each major system component, provide nameplates to identify the manufacturer's name and address, and the model and serial number of the component.
- G. Finishes:
- 1. Enclosures and Components:
 - a. For indoor and outdoor enclosures and components, provide the manufacturer's standard finish applied over a corrosion-resistant pretreatment and a compatible primer.

2.02 ACCESSORIES

- A. Roof Curbs, Equipment Supports, and Roof Penetrations:
 - 1. Provide roof curbs, equipment supports, and roof penetrations for remote radiators complying with the requirements specified in Section 07720, Roof Accessories.
- B. Piping Materials:
 - 1. Provide flexible connectors and steel piping materials complying with the requirements specified in Section 15182, Hydronic Piping.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Materials specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.



- a. Fourteen days before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.
2. Prototype Testing:
 - a. Factory-test a prototype engine-generator set of the same engine model to be provided under this Section, constructed of identical or equivalent components, and equipped with identical or equivalent accessories.
 - b. Test Procedure:
 - 1) Test the prototype engine-generator set in accordance with the procedures for Level 1 Energy Converters specified in NFPA 110, and in accordance with the procedures specified in IEEE 115.
 - c. Acceptance Criteria:
 - 1) Submit a certified Summary of the Prototype-Unit Test report to the Program/Project Manager for information.
3. Project-Specific Equipment Tests:
 - a. Test Procedure:
 - 1) Before shipping the diesel electric generator equipment, have the manufacturer perform the following factory-tests of the engine-generator set and other system components and accessories manufactured specifically for this Contract at the rated load and power factor, prepare certified test reports documenting the results of the tests, and within 10 days of the completion of the test submit the test reports to the Program/Project Manager for information:
 - a) Test the components and accessories that will be furnished with the unit to be provided that are not identical to those on the prototype tested to demonstrate their compatibility and reliability.
 - b) Run the diesel electric generators at full load.
 - c) Run the diesel electric generators at maximum power.
 - d) Test the diesel electric generator's voltage regulation.
 - e) Test the diesel electric generator's transient and steady-state governing.
 - f) Test the diesel electric generator's single-step load pickup.
 - g) Test the diesel electric generator's safety shutdown.
 - b. Acceptance Criteria:
 - 1) Submit the following information to the Program/Project Manager for information:
 - a) Certified Test Reports for Equivalent Components and Accessories:
 - (1) For components and accessories that are equivalent, but not identical, to those tested on prototype unit, prepare certified test reports.



- b) Certified Summary of Performance Tests:
 - (1) Prepare a Certified Summary of Performance Tests to certify compliance with the specified requirement to meet the performance criteria for sensitive loads.
 - (a) Show evidence that the units to be shipped for this Contract comply with the specified requirements.
 - (b) Include a report of the sound generation.
 - (c) Include a report of the exhaust emissions showing compliance with applicable regulations.
 - (2) Certification of Torsional Vibration Compatibility:
 - (a) Certify that the units comply with the torsional vibration compatibility requirements specified in NFPA 110.
- B. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when switchgear for this Contract are being fabricated and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the diesel electric generator installer present, examine the areas, equipment bases, and conditions where the diesel electric generators will be installed for compliance with the requirements for installation and other conditions affecting the packaged engine-generator performance.
 - 2. Examine the roughing-in of piping and electrical connections to verify their actual locations before installing the packaged engine-generator units.
- B. Evaluation and Assessment:
 - 1. Proceed installing the diesel electric generators only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the diesel electric generators.
- B. Surface Preparation:
 - 1. Concrete Bases:
 - a. Provide flat concrete pads to support the diesel electric generators.



- 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the diesel electric generators.
- 2) Extend the base no less than 3 inches in all directions beyond the maximum dimensions of the diesel electric generators, unless otherwise indicated on the Contract Drawings, or unless required otherwise specified.
- b. Construct the concrete bases in accordance with Section 03200, Concrete Reinforcement.
 - 1) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.
- c. Place and secure anchorage devices.
 - 1) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - 2) Install anchor bolts to the elevations required for proper attachment to the diesel electric generators.
 - 3) Cast anchor-bolt inserts into the concrete bases.

3.03 INSTALLATION

- A. Install the packaged engine generators in accordance with manufacturers' installation and alignment instructions and with the requirements specified in NFPA 110.
 1. Submit the packaged engine generator manufacturers' written installation and alignment instructions to the Program/Project Manager for information.
- B. Install packaged engine generator with elastomeric isolator pads on the concrete base.
 1. Secure the engine generator sets to anchor bolts installed in the concrete bases.
- C. Engine Mufflers:
 1. Install the engine muffler, and connect it via flexible connectors to Schedule 40, black steel piping having welded joints and the same diameter as the muffler outlet.
 - a. Installation the flexible connectors and steel piping materials in accordance with the requirements specified in Section 15182, Hydronic Piping.
 2. Install Schedule 40, black steel condensate drain piping with welded joints to the muffler drain outlet, and having the full size of the drain connection with a shutoff valve and stainless-steel flexible connectors.



- a. Installation the flexible connectors and steel piping materials in accordance with the requirements specified in Section 15182, Hydronic Piping.
 3. Install thimbles at walls.
 4. Provide remote shut off in accordance with City of Phoenix and Aviation requirements. Location of remote shut off shall be coordinated with Aviation prior to installation.
 5. Provide platform around generator to conform to OSHA 1910 that shall be a minimum of 3' wide.
- D. Special Techniques:
 1. Electrical Wiring:
 - a. Install electrical devices furnished by the equipment manufacturers but not specified to be factory mounted.
 2. Identification:
 - a. Identify piping, ductwork, and other mechanical components in accordance with the requirements specified in Section 15075, Mechanical Identification.
 - b. Identify field-installed wiring and components and provide warning signs in accordance with the requirements specified in Section 16075, Electrical Identification.
 - c. Electrical systems shall be identified by color including normal, life safety, optional stand-by, and legally required stand-by in accordance with NFPA 70 and Aviation standard.
- E. Interface with Other Work:
 1. Install piping in accordance with the requirements specified in other Sections
 - a. Connect fuel, cooling-system, and exhaust-system piping adjacent to the packaged engine generator so access for service and maintenance is maintained.
 - b. Provide flexible connectors to connect the cooling-system water piping to the engine-generator sets and the heat exchangers, and to connect the engine exhaust pipes to the engines.
- F. Systems Integration:
 1. Ground the packaged engine generator equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 2. Connect the packaged engine generator wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:



1. During the period when diesel electric generators are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Testing Agency Responsibilities:
 - a. Field Quality-Control Reports:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The diesel electric generators included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
 - 2) Have the Testing Agency record the adjustable relay settings and measured insulation resistances, time delays, and other values and observations in the Field Quality-Control Reports.
 - b. Coordinate the Site tests with the tests for transfer switches provided under Section 16497, Automatic Transfer Switches, and run the tests concurrently.
 - c. Furnish test instruments that have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of the test results.
 - 1) Make the calibration records available for examination upon request.
 - d. Test Labeling:
 - 1) Have the Testing Agency attach a label or tag to each tested component indicating satisfactory completion of the tests for that component.



- a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
- B. Tests and Inspections:
 1. NETA Acceptance Testing:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency perform each electrical test for "AC Generators and for Emergency Systems" specified in ANSI/NETA ATS.
 - 2) Have the Testing Agency prepare a certified NETA Acceptance Testing Field Quality Control Report that identifies the diesel electric generators included and documents the NETA acceptance testing, and submit the Report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Testing Agency certification of compliance with the test parameters specified in ANSI/NETA ATS constitutes acceptance of the NETA Acceptance Testing.
 2. NFPA 110 Acceptance Test:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency perform the specified in NFPA 110 that are additional to those specified herein, including, but not limited to, the single-step full-load pickup test.
 - b. Acceptance Criteria:
 - 1) Testing Agency certification of compliance with the test parameters specified in NFPA 110 constitutes acceptance of the NFPA 110 Acceptance Test.
 3. Battery Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency equalize the charging of the battery cells in accordance with the manufacturer's written instructions.
 - 2) Record individual cell voltages.
 - 3) Measure the charging voltage and voltages between available battery terminals for full-charging and float-charging conditions.
 - a) Check the electrolyte level and specific gravity under both conditions.
 - 4) Test the contact integrity of all connectors.
 - a) Perform an integrity load test and a capacity load test for the battery.



- 5) Verify the acceptance of charge for each element of the battery after discharge.
 - b. Acceptance Criteria:
 - 1) Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency verify the specified rates of charge for both equalizing and float-charging conditions.
 - b. Acceptance Criteria:
 - 1) Battery-chargers having the specified rates of charge for both equalizing and float-charging conditions pass the Battery-Charger Tests.
5. System Integrity Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency methodically verify the proper installation, connection, and integrity of each element of the engine-generator system before and during system operation.
 - 2) Check for air, exhaust, and fluid leaks.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators having each element the properly installed, connected, and having integrity before and during system operation pass the System Integrity Tests.
6. Exhaust-System Back-Pressure Test:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency use a manometer with a scale exceeding 40 inches w. g. (120kPa) connected to the exhaust line close to the engine exhaust manifold to verify that the back pressure at the full-rated load is within the manufacturer's written allowable limits for the engine.
 - b. Acceptance Criteria:
 - 1) Exhaust systems having back pressures verified to be within the manufacturer's written allowable limits at the full-rated load for the engine pass the Exhaust-System Back-Pressure Test.
7. Exhaust Emissions Test:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency verify that the exhaust emissions comply with the applicable government test criteria.
 - b. Acceptance Criteria:



- 1) Exhausts whose emissions complying with the applicable government test criteria pass the Exhaust Emissions Test.
8. Voltage and Frequency Transient Stability Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency use a recording oscilloscope to measure the voltage and frequency transients for 50 percent and 100 percent step-load increases and decreases, and to verify that the performance is as specified.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators whose voltage and frequency transients performance is as specified pass the Voltage and Frequency Transient Stability Tests.
9. Harmonic-Content Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency measure the harmonic content of the output voltage under 25 percent and at 100 percent of the rated linear load, and verify that the harmonic content is within specified limits.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators whose output voltage harmonic content is within specified limits pass the Harmonic-Content Tests.
10. Noise Level Tests:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency measure the A-weighted level of noise emanating from the generator-set installation, including the engine exhaust and cooling-air intake and discharge, at 4 locations within the area of the generator, and compare the measured levels with the specified values.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators whose noise level is within the limits specified pass the Noise Level Tests.
11. Leak Test:
 - a. Test Procedure:
 - 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency charge the system, and test it for leaks.
 - b. Acceptance Criteria:
 - 1) Repair the leaks discovered, and retest repaired units until no leaks exist.
12. Operational Test:
 - a. Test Procedure:



- 1) After the diesel electric generators are installed and the electrical circuitry has been energized, have the Testing Agency start the units to confirm the proper motor rotation and unit operation.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators operating normally as specified pass the Operational Test.
13. Infrared Scanning:
 - a. Test Procedure:
 - 1) Instruments and Equipment:
 - a) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - b) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
 - 2) Initial Infrared Scanning:
 - a) After Substantial Completion, but not more than 60 days after Final Acceptance, have the Testing Agency perform an infrared scan of each power wiring termination and each bus connection.
 - b) Remove the access panels so terminations and connections are accessible to the portable infrared scanner.
 - 3) Follow-up Infrared Scanning:
 - a) Have the Testing Agency perform an additional follow-up infrared scan of each termination and each bus connection 11 months after the date of Substantial Completion.
 - 4) Have the Testing Agency prepare a certified Field Quality Control Report that identifies the terminations and connections checked and describes the infrared scanning results, and have the Testing Agency submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Significant deviations from normal temperature values are cause for the enclosed switch or circuit breaker under test to fail the infrared scan.
- C. Non-Conforming Work
 1. Correct deficiencies identified by the tests and observations, and retest the corrected units until the specified requirements are complied with.
 2. Remove malfunctioning units, and replace them with conforming replacement units.
 - a. Replace damaged and malfunctioning controls and equipment.
 - b. Retest the replacement units as specified herein.
- D. Manufacturer Services:



- 4- Engage a factory-authorized service representative to inspect the diesel electric generator components, connections, and equipment installation, and to assist in testing.

3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 15995, Commissioning of Mechanical Systems, for the piping systems, ductwork, air handlers, air conditioning (AC) and heat pump (HP) packaged units, air terminal units, heat exchangers, the building automation system, fire and smoke dampers, indoor air quality, equipment sound control, equipment vibration control, and testing, adjusting and balancing work pertinent to the Work of this Section.

3.06 ADJUSTING

- #### A. Test and adjust controls and safeties.

3.07 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Training:

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain diesel electric generators in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- #### A. Take steps to insure that installed diesel electric generators are protected during subsequent construction activities.

3.10 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the packaged engine generators and accessories for inclusion in emergency and Operation and Maintenance manuals as specified in Section 01780, Closeout Submittals.
 - a. Include a list of tools and replacement items recommended to be stored at the Site for ready access.



- 1) Include part and drawing numbers, current unit prices, and a source of supply.
 2. Submit the operation and maintenance data for the packaged engine generators and accessories to the Program/Project Manager for information.
- A. Initial Maintenance Service:
1. Beginning at Substantial Completion, provide 12 months of full maintenance service to be performed by skilled employees of the manufacturer's designated service organization.
 2. Provide quarterly exercising of the equipment to check for proper starting, load transfer, and running under load.
 3. Provide routine preventive maintenance as recommended by the manufacturer, and adjusting as required for proper operation.
 4. Provide parts and supplies that are the same as those used in the manufacture and installation of the original equipment.
 5. Submit an executed Diesel Electric Generator Maintenance Service Agreement to the Program/Project Manager.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16264

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for 3-phase, on-line, double-conversion, static-type uninterruptible power supply (UPS) units having the following features:
 - a. Surge suppression.
 - b. Input harmonics reduction.
 - c. Rectifier-charger.
 - d. Inverter.
 - e. Static bypass transfer switch.
 - f. Battery and battery disconnect device.
 - g. Internal automatic/manual bypass, plus an external make before break maintenance bypass/isolation switch.
 - h. Remote uninterruptible power supply (UPS) monitoring provisions.
 - i. Battery monitoring.
 - j. Remote monitoring.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01360 - Sustainable Design Requirements.
3. Section 01770 - Closeout Procedures.
4. Section 01780 - Closeout Submittals.
5. Section 01810 - Commissioning.
6. Section 03100 - Concrete Forms and Accessories.
7. Section 03200 - Concrete Reinforcement.
8. Section 03300 - Cast-In-Place Concrete.
9. Section 13453 - Supervisory Control and Data Acquisition (SCADA).
10. Section 16070 - Hangers and Supports.
11. Section 16071 - Seismic Controls.
12. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. AC: Alternating electric current.
2. dBA: Decibels, referenced to the A-weighting filter curve defined in IEC 61672.
3. EMI: Electromagnetic interference.
4. LCD: Liquid-crystal display.
5. LED: Light emitting diode.



6. RMS: Root-mean-square.
7. THD: Total harmonic distortion.
8. UPS: Uninterruptible power supply.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
3. RMS: Total harmonic distortion value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
4. RS-232: A Telecommunications Industry Association (TIA) recommended standard for asynchronous serial data communications between terminal devices.
5. X/R Ratio: The ratio of electrical reactance to electrical resistance in the electrical power supply.

C. Reference Standards:

1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C62.41.1 – IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - b. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
5. National Electrical Manufacturers Association (NEMA):
 - a. NEMA PB 2 – Deadfront Distribution Switchboards.
6. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - a. Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
7. National Fire Protection Association (NFPA):



- a. NFPA 70 – National Electrical Code® (NEC).
8. National Institute of Standards and Technology (NIST):
 - a. Standards Services Division,
<http://ts.nist.gov/standards/accreditation/index.cfm>:
9. Telecommunications Industry Association (TIA):
 - a. ANSI/TIA 232-F – Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
10. Underwriters Laboratories, Inc. (UL):
 - a. UL 891- Switchboards.
 - b. UL 1778 - Uninterruptible Power Systems.
11. United States Government:
 - a. Federal Communication Commission (FCC):
 - 1) 47 CFR 15 Radio Frequency Devices.
 - b. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Enclosures.
 - 2) Rectifier-chargers.
 - 3) Inverters.
 - 4) Static bypass transfer switches.
 - 5) Batteries.
 - 6) Controls and indications.
 - 7) Maintenance bypass/isolation switches.
 - 8) Equipment for remote monitoring of the uninterruptible power supply (UPS).
 - 9) Basic battery monitoring equipment.
 - 10) Additional battery monitoring items.
 - 11) Battery-cycle warranty monitoring equipment.



- b. Shop Drawings:
 - 1) Static uninterruptible power supplies.
 - 2) Wiring diagrams.
 - c. Certificates:
 - 1) Certificates of Compliance for each type of uninterruptible power supply (UPS) equipment.
 - 2) Seismic Qualification Certificates.
 - d. Qualification Statements:
 - 1) Qualifications of the power quality specialist.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Static uninterruptible power supply manufacturer's written installation instructions.
 - 2) Battery manufacturer's written charging instructions.
 - b. Site Quality Control Submittals:
 - 1) Field Quality Control Performance Test Report.
 - c. Manufacturer's Reports:
 - 1) Manufacturer certified factory test reports documenting the results of the equipment tests.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the static uninterruptible power supplies and accessories.
 - b. Warranty Documentation:
 - 1) Static Uninterruptible Power Supply Warranty.
 - c. Record Documentation:
 - 1) Individual cell voltages of the batteries.
 - d. Software:
 - 1) Documentation and backup copies of the software for remote monitoring of the uninterruptible power supply (UPS) system.
 - 2) Documentation and backup copies of the software for storing and analyzing battery data.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:



- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of static uninterruptible power supplies and accessories.
 - 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
- 1. Power Quality Specialist's Qualifications:
 - a. Employ engineering technician or a registered electrical Professional Engineer, at a minimum currently certified as a NICET Level 4 technician by the National Institute for Certification in Engineering Technologies (NICET) in accordance with the requirements for, specified in the Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual, and experienced in performance testing UPS installations and in performing power quality surveys similar to that required under this Section.
 - b. Submit the qualifications of the power quality specialist to the Program/Project Manager for approval.
 - 2. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with the requirements specified in ANSI/NETA ETT.
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.



C. Certifications:

1. Manufacturer's Certificates of Compliance:
 - a. For each type of uninterruptible power supply (UPS) equipment, submit Manufacturer's Certificates of Compliance wherein the manufacturer of these items certifies that they comply with the specified requirements, to the Program/Project Manager for approval.
2. Electrical Listing and Labeling:
 - a. Provide electrical components, devices, and accessories that are listed and labeled for the location the product is installed in, and the application intended, by a Nationally Recognized Testing Laboratory (NRTL), as defined in Article 100 of NFPA 70, acceptable to the Authorities Having Jurisdiction (AHJ), unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
3. Seismic Qualification Certificates:
 - a. Have the manufacturer prepare Seismic Qualification Certificates certifying that the uninterruptible power supply (UPS) equipment is capable of withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
 - 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
 - b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Package and protect materials to limit field repairs.



- a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.
- B. Storage and Handling Requirements:
 - 1. Store and handle products in a manner that will prevent material damage and deterioration or contamination from the elements.
- C. Packaging Waste Management:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. Remove loose packing and flammable materials from inside the uninterruptible power supply (UPS) equipment.
 - 3. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 - 1. Provide an uninterruptible power supply (UPS) equipment capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except for battery performance.
 - a. Ambient Temperature:
 - 1) Provide uninterruptible power supply (UPS) electronic components capable of operating within the range 32 degrees Fahrenheit to 104 degrees Fahrenheit.
 - 2) Provide uninterruptible power supply (UPS) batteries capable of operating within the range 41 degrees Fahrenheit to 95 degrees Fahrenheit.
 - b. Relative Humidity:
 - 1) Provide uninterruptible power supply (UPS) electronic components capable of operating within the non-condensing relative humidity range of 0 percent to 95 percent.
 - c. Altitude:
 - 1) Provide uninterruptible power supply (UPS) equipment capable of operating from sea level up to 4000 feet (1216m) above sea level.

1.08 WARRANTY

- A. Manufacturer Warranty:
 - 1. Static Uninterruptible Power Supply Warranty:
 - a. Warrant the static uninterruptible power supply fully against defects within the 1-year period after the Date of Substantial Completion:
 - 1) Submit a Static Uninterruptible Power Supply Warranty on the static uninterruptible power supply manufacturer's standard form, without monetary limitation including for parts, labor, and travel, in



which the static uninterruptible power supply manufacturer agrees to repair or replace static uninterruptible power supplies and associated auxiliary components that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

B. Special Warranty:

1. Value Regulated Battery Warranty:

a. Warrant the value regulated batteries fully against defects within the 3-year period after the Date of Substantial Completion:

- 1) Submit a Value Regulated Battery Warranty on the value regulated battery manufacturer's standard form, without monetary limitation, in which the value regulated battery manufacturer agrees to repair or replace value regulated batteries that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 STATIC UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

A. Manufacturers:

1. Manufacturer List:

a. Subject to compliance with the requirements specified herein, provide the Basis-of-Design product indicated in the Contract Documents or a comparable product manufactured by one of the manufacturers listed.

b. Manufacturers:

- 1) Liebert Corporation, Basis-of-Design Product: "NX" Series UPS System, <https://www.vertivco.com/en-us/products/brands/liebert/>.
- 2) Approved equal.

2. Substitution Limitations:

a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

b. National Electrical Code (NEC):

- 1) Provide products and installation complying with the requirements specified for static uninterruptible power supplies in NFPA 70.

c. Electromagnetic Interference (EMI) Emissions:



- 1) Provide the Work of this Section in accordance with the Federal Communication Commission (FCC) Rules and Regulations and with the requirements for Class A equipment specified in 47 CFR 15.

C. Performance:

1. Provide static uninterruptible power supplies that perform as specified herein while supplying the rated full-load current, composed of any combination of linear and nonlinear loads, up to 100 percent of the nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
 - a. The inverter is switched to battery source.
 - b. Steady-state ac input voltage deviates up to plus or minus 10 percent from the nominal voltage.
 - c. Steady-state input frequency deviates up to plus or minus 5 percent from the nominal frequency.
 - d. The total harmonic distortion (THD) of the input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
 - e. The load is 100 percent unbalanced continuously.
2. Minimum Duration of Supply:
 - a. If a battery is the sole energy source supplying the rated full UPS load current at 80 percent power factor, provide static uninterruptible power supplies capable of supply power for 15 minutes.
3. Input Voltage Tolerance:
 - a. Provide static uninterruptible power supplies having system steady-state and transient output performance that remains within the specified tolerances when the steady-state alternating electric current (AC) input voltage varies plus 10 percent, minus 20 percent from the nominal voltage.
4. Overall Uninterruptible Power Supply (UPS) Efficiency:
 - a. Provide static uninterruptible power supplies having an overall efficiency equal to or greater than 94 percent at 100 percent load, 94 percent at 75 percent load, and 94 percent at 50 percent load.
5. Maximum Acoustical Noise:
 - a. Provide static uninterruptible power supplies having a maximum acoustical noise of 80 pounds, using "A" weighting, emanating from any uninterruptible power supply component under any condition of normal operation, measured 10 feet from the nearest surface of the component enclosure.
6. Maximum Energizing Inrush Current:
 - a. Provide static uninterruptible power supplies having a maximum energizing inrush current 8 times the full-load current.
7. Maximum Alternating Current (AC) Output-Voltage Regulation:



- a. For loads up to 50 percent unbalanced, provide static uninterruptible power supplies providing maximum alternating electric current (AC) output-voltage regulation of plus or minus 2 percent over the full range of the battery voltage.
8. Output Frequency:
 - a. Provide static uninterruptible power supplies providing an output frequency of 60 Hertz, plus or minus 0.5 percent over the full range of the input voltage, load, and battery voltage.
9. Harmonic Distortion Limitation:
 - a. Provide static uninterruptible power supplies that limit harmonic distortion of the input current to the uninterruptible power supply (UPS) as follows:
 - 1) Provide either a tuned harmonic filter or an arrangement of rectifier-charger circuits that limit the total harmonic distortion (THD) to a maximum of 10 percent at the rated full UPS load current for power sources with an X/R ratio between 2 and 30.
10. Maximum Harmonic Content of Output-Voltage Waveform:
 - a. Provide static uninterruptible power supplies that provide a maximum total harmonic content of 5 percent RMS of the output-voltage waveform, and 3 percent RMS for any single harmonic, for a 100 percent rated nonlinear load current with a load crest factor of 3.0.
11. Minimum Overload Capacity of Uninterruptible Power Supply (UPS) at the Rated Voltage:
 - a. Provide static uninterruptible power supplies that provide a minimum overload capacity of the uninterruptible power supply (UPS) at the rated voltage of 125 percent of the rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
12. Maximum Output-Voltage Transient Excursions from Rated Value:
 - a. Provide static uninterruptible power supplies that keep the voltage within the percentages of the rated value listed below, and that recover to and remain within plus or minus 2 percent of that value within 100 milliseconds, for the following instantaneous load changes stated as percentages of the rated full uninterruptible power supply (UPS) load:
 - 1) 50 Percent: Plus or minus 5 percent.
 - 2) 100 Percent: Plus or minus 5 percent.
 - 3) Loss of Alternating Current (AC) Input Power: Plus or minus 1 percent.
 - 4) Restoration of Alternating Current (AC) Input Power: Plus or minus 1 percent.
13. Input Power Factor:
 - a. Provide static uninterruptible power supplies providing a minimum input power factor of 0.85 lagging when the supply voltage and current are at the nominal rated values, and the uninterruptible power supply (UPS) is supplying the rated full-load current.
14. Seismic Performance:



- a. Provide static uninterruptible power supplies that include the seismic anchoring certified for the local seismic zone application.
- D. Design Criteria:
 - 1. Provide static uninterruptible power supply (UPS) systems that are listed and labeled under UL 1778 by a Nationally Recognized Testing Laboratory (NRTL), and comply with the following design requirements:
 - a. Electronic Equipment:
 - 1) Provide uninterruptible power supply (UPS) systems having solid-state electronic devices with hermetically sealed, semiconductor elements.
 - a) The electronic devices include the rectifier-charger, inverter, static bypass transfer switch, and system controls.
 - b. Control Assemblies:
 - 1) Provide control assemblies mounted on modular plug-ins, and that are readily accessible for maintenance.
 - c. Surge Suppression:
 - 1) Provide surge suppression that protects the internal uninterruptible power supply (UPS) components from surges that enter at each alternating current (AC) power input connection, including the main disconnect switch, the static bypass transfer switch, and the maintenance bypass/isolation switch.
 - a) Protect rectifier-charger, inverter, controls, and output components.
 - b) Provide factory-installed surge suppressors tested in accordance with the requirements specified in IEEE C62.41.1 and with the requirements for Category B suppressors specified in IEEE C62.41.2.
 - (1) Additional Surge Protection:
 - (a) Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
 - (b) Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand the stresses imposed by 40 Hertz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
 - d. Maintainability Features:
 - 1) Mount the rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins that are readily accessible for maintenance.
 - e. Seismic-Restraint Design:



- 1) Provide uninterruptible power supply (UPS) assemblies, subassemblies, and components, including the fastenings and supports, mounting, and anchorage devices for them, that are designed and fabricated to withstand static and seismic forces.
 - f. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity:
 - 1) Provide output circuit neutral buses, conductors, and terminals rated for at least the phase current times a multiple of 1.73.
 2. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of static uninterruptible power supply specified.
 - 1) Include data on the static uninterruptible power supply features, components, ratings, and performance.
 - b. Submit the Product Data to the Program/Project Manager for approval.
 3. Shop Drawings:
 - a. Prepare Shop Drawings for the static uninterruptible power supplies that include plans, elevations, sections, details, and attachments to other work.
 - 1) Detail equipment assemblies; and indicate the dimensions, weights, loads, components, and location and size of each field connection.
 - 2) Show the access, workspace, and clearance requirements.
 - 3) Furnish details of the control panels.
 - 4) Show the battery arrangement.
 - b. Wiring Diagrams:
 - 1) Furnish power, signal, and control wiring diagrams for the static uninterruptible power supply.
 - c. Submit the Shop Drawings and wiring diagrams to the Program/Project Manager for approval.
- E. Operation Sequences:
 1. Automatic Operation:
 - a. Normal Conditions:
 - 1) Under normal automatic operation, supply the load with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
 - b. Abnormal Supply Conditions:
 - 1) If the normal supply deviates from the specified and adjustable voltage, voltage waveform, or frequency limits, supply energy from the battery to maintain a constant, regulated inverter power output to the load without switching or disturbance.
 - 2) If normal power fails, supply energy from the battery through the inverter to maintain supply-regulated power to the load without switching or disturbance.



- 3) When power is restored at the normal supply terminals of the system, the external source must be automatically synchronized by controls with the inverter before transferring the load.
 - a) The rectifier-charger must then supply power to the load through the inverter and simultaneously recharge the battery.
 - 4) If the battery becomes discharged and normal supply is available, the rectifier-charger must charge the battery.
 - a) On reaching full charge, the rectifier-charger must automatically shift to float-charge mode.
 - 5) If any element of the uninterruptible power supply (UPS) system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch must switch the load to the normal alternating current (AC) supply circuit without disturbance or interruption.
 - 6) If a fault occurs in the system supplied by the uninterruptible power supply (UPS), and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch must operate to bypass the fault current to the normal alternating current (AC) supply circuit for fault clearing.
 - 7) When the fault has cleared, the static bypass transfer switch must return the load to the uninterruptible power supply (UPS) system.
 - 8) If the battery is disconnected, the uninterruptible power supply (UPS) must continue to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
2. Manual Operation:
 - a. Turning the inverter off must cause the static bypass transfer switch to transfer the load directly to the normal alternating current (AC) supply circuit without disturbance or interruption.
 - b. Turning the inverter on must cause the static bypass transfer switch to transfer the load to the inverter.
 3. Maintenance Bypass/Isolation Switch Operation:
 - a. Provide a maintenance bypass/isolation switch interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode.
 - b. Provide a maintenance bypass/isolation switch that allows manual selection from among the following 3 conditions without interrupting the supply to the load during switching:
 - 1) Full Isolation:
 - a) When full isolation is selected, supply the load bypassing the uninterruptible power supply (UPS).
 - b) The normal uninterruptible power supply (UPS) alternating current (AC) input circuit, static bypass transfer switch, and UPS load terminals must be completely disconnected from external circuits.
 - 2) Maintenance Bypass:



- a) When maintenance bypass is selected, supply the load, bypassing the uninterruptible power supply (UPS)
 - (1) Energize the uninterruptible power supply (UPS) alternating current (AC) supply terminals to permit operational checking, but isolate system load terminals from the load.
 - 3) Normal:
 - a) When normal is selected, energize the normal uninterruptible power supply (UPS) alternating current (AC) supply terminals and supply the load through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.
- F. Materials:
 - 1. Enclosures:
 - a. Unless otherwise indicated in the Contract Documents, provide enclosures complying with the requirements for NEMA Type 1 enclosures specified in NEMA 250.
 - b. Uninterruptible Power Supply (UPS) Cabinet Ventilation:
 - 1) Provide redundant fans or blowers that draw in ambient air near the bottom of the cabinet and discharge it near the top rear.
 - 2. Rectifier-Chargers:
 - a. Capacity:
 - 1) Provide rectifier-chargers adequate to supply the inverter during the rated full output load conditions and simultaneously recharge the battery from a fully discharged condition to 95 percent of the full charge within 10 times the rated discharge time for the duration of supply under battery power at the full load.
 - b. Output Ripple:
 - 1) Provide rectifier-chargers limiting the output ripple by filtering the output to less than 0.5 percent of the rated current, peak to peak.
 - c. Control Circuits:
 - 1) Provide rectifier-chargers having control circuits that are immune to frequency variations within the rated frequency ranges of the normal and emergency power sources.
 - 2) Response Time:
 - a) Provide rectifier-chargers having field-adjustable response times to maximize compatibility with the local generator-set power source.
 - d. Battery Float-Charging Conditions:
 - 1) Provide rectifier-chargers having battery float-charging provisions complying with the battery manufacturer's written instructions for the battery terminal voltage and charging current required for maximum battery life.
 - 3. Inverters:
 - a. Provide a pulse-width modulated inverter having a sinusoidal output.



- 1) Provide a bypass phase synchronization window adjustment to optimize compatibility with the local engine-generator-set power source.
4. Static Bypass Transfer Switches:
 - a. Provide solid-state switching devices capable of providing uninterrupted transfer.
 - 1) Provide a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.
 - b. Switch Rating:
 - 1) Provide a static bypass transfer switch capable of providing continuous duty at least at the rated full uninterruptible power supply (UPS) load current.
5. Batteries:
 - a. Provide valve-regulated, premium, heavy-duty, recombinant, lead-calcium battery units that have been factory-assembled in an isolated compartment or in a separate matching cabinet, complete with a battery disconnect switch.
 - 1) Arrange the battery units for drawout removal of the battery assembly from the cabinet for testing and inspection.
 - b. Seismic-Restraint Design:
 - 1) Provide battery racks, cabinets, assemblies, subassemblies, and components, including the fastenings and supports, mounting, and anchorage devices for them, that are designed and fabricated to withstand static and seismic forces.
6. Controls and Indications:
 - a. Provide group displays, indicating devices, and basic system controls on a common control panel mounted on the front of uninterruptible power supply (UPS) enclosure.
 - 1) Provide indications capable of displaying plain-language messages on a digital LCD or LED.
 - 2) Alarms include audible signals and visual displays.
 - b. Provide at least the following displays, indicating devices, and controls:
 - 1) Indicating Devices:
 - a) Quantitative Indications:
 - (1) Input voltage, each phase, line to line.
 - (2) Input current, each phase, line to line.
 - (3) Bypass input voltage, each phase, line to line.
 - (4) Bypass input frequency.
 - (5) System output voltage, each phase, line to line.
 - (6) System output current, each phase.
 - (7) System output frequency.
 - (8) Direct current (DC) bus voltage.
 - (9) Battery current and direction (charge/discharge).
 - (10) Elapsed time discharging battery.
 - b) Basic Status Condition Indications:



- (1) Normal operation.
- (2) Load-on bypass.
- (3) Load-on battery.
- (4) Inverter off.
- (5) Alarm condition.
- c) Alarm Indications:
 - (1) Bypass alternating current (AC) input overvoltage or undervoltage.
 - (2) Bypass alternating current (AC) input overfrequency or underfrequency.
 - (3) Bypass alternating current (AC) input and inverter out of synchronization.
 - (4) Bypass alternating current (AC) input wrong-phase rotation.
 - (5) Bypass alternating current (AC) input single-phase condition.
 - (6) Bypass alternating current (AC) input filter fuse blown.
 - (7) Internal frequency standard in use.
 - (8) Battery system alarm.
 - (9) Control power failure.
 - (10) Fan failure.
 - (11) Uninterruptible power supply (UPS) overload.
 - (12) Battery-charging control faulty.
 - (13) Input overvoltage or undervoltage.
 - (14) Input transformer overtemperature.
 - (15) Input circuit breaker tripped.
 - (16) Input wrong-phase rotation.
 - (17) Input single-phase condition.
 - (18) Approaching end of battery operation.
 - (19) Battery undervoltage shutdown.
 - (20) Maximum battery voltage.
 - (21) Inverter fuse blown.
 - (22) Inverter transformer overtemperature.
 - (23) Inverter overtemperature.
 - (24) Static bypass transfer switch overtemperature.
 - (25) Inverter power supply fault.
 - (26) Inverter transistors out of saturation.
 - (27) Identification of faulty inverter section/leg.
 - (28) Inverter output overvoltage or undervoltage.
 - (29) Uninterruptible power supply (UPS) overload shutdown.
 - (30) Inverter current sensor fault.
 - (31) Inverter output contactor open.
 - (32) Inverter current limit.
- 2) Controls:
 - a) Inverter on-off.
 - b) Uninterruptible power supply (UPS) start.



- c) Battery test.
 - d) Alarm silence/reset.
 - e) Output-voltage adjustment.
 - 3) Provide the sensors, transducers, terminals, relays, and wiring required to support the listed displays, indicating devices, and controls.
 - c. Provide dry-form "C" contacts for remote indication of the following conditions:
 - 1) Uninterruptible power supply (UPS) on battery.
 - 2) Uninterruptible power supply (UPS) on-line.
 - 3) Uninterruptible power supply (UPS) load-on bypass.
 - 4) Uninterruptible power supply (UPS) in alarm condition.
 - 5) Uninterruptible power supply (UPS) off (maintenance bypass closed).
 - d. Emergency Power Off Switch:
 - 1) Provide an emergency power off switch capable of being locally operated and being activated by external dry contacts.
7. Maintenance Bypass/Isolation Switches:
- a. Provide a manually operated switch or an arrangement of switching devices having a mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
 - 1) Electrically and mechanically interlock the switch to prevent interrupting power to the load when switching to the bypass mode.
 - a) Connect the switch so it electrically isolates other uninterruptible power supply (UPS) components to permit safe servicing.
 - b. Provide a maintenance bypass/isolation switch complying with the requirements specified in NEMA PB 2 and UL 891.
 - c. Switch Rating:
 - 1) Provide a maintenance bypass/isolation switch rated for continuous duty at the rated full uninterruptible power supply (UPS) load current.
 - d. Mounting Provisions:
 - 1) Mount the maintenance bypass/isolation switch inside the system cabinet.
 - e. Provide a key interlock that requires the maintenance bypass/isolation switch to be unlocked before switching from the normal position with a key that is released only when the uninterruptible power supply (UPS) is bypassed by the static bypass transfer switch.
 - 1) Provide a lock designed specifically for mechanical and electrical component interlocking.
8. Equipment for Remote Monitoring of the Uninterruptible Power Supply (UPS):
- a. Provide a communication module in the unit's control panel that provides the capability to remotely monitor the status, parameters, and



alarms specified in Subparagraph 2.01.F.6 by a remote computer, and that includes the following features:

- 1) Connectors and network interface units or modems for data transmission via an RS-232 link.
 - a) Provide software designed for controlling and monitoring uninterruptible power supply (UPS) functions, and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for the use of the monitoring indications and development of meaningful reports.
 - (1) Provide software designed to permit storage and analysis of power-line transient records.
 - (2) Designs for the Windows applications, software, and the remote computer are not provided under this Section.
 - b) Software and Hardware:
 - (1) Provide software and hardware that is compatible with that specified in Section 13453, Supervisory Control and Data Acquisition (SCADA).
 - (2) Submit documentation and backup copies of the software for remote monitoring of the uninterruptible power supply (UPS) system to the Program/Project Manager.
 - c) The remote computer and the connecting signal wiring are not provided under this Section.
9. Basic Battery Monitoring Equipment:
 - a. Battery Ground-Fault Detector:
 - 1) Provide a battery ground-fault detector that initiates an alarm when the resistance to ground of the positive or negative bus of the battery is less than 5000 ohms.
 - b. Smoke/High-Temperature Detector:
 - 1) Provide a battery compartment smoke/high-temperature detector that initiates an alarm when smoke or a temperature greater than 75 degrees Celsius occurs within the compartment.
 - c. Annunciation of Alarms:
 - 1) To communicate alarm/status information, annunciate the alarms at the uninterruptible power supply (UPS) control panel and over a network interface.
 - d. Manufacturers:
 - 1) Albercorp, "BOS" System, <http://www.alber.com>.
 - 2) Approved equal.
10. Additional Battery Monitoring Items:
 - a. Provide monitoring features and components that include the following:
 - 1) Provide factory-wired sensing leads to the cell and battery terminals, and to the cell temperature sensors.
 - 2) Provide connections for data transmission via an RS-232 link, network interface, and external signal wiring to a remote computer.



- a) The external signal wiring and remote computer are not provided under this Section.
 - 3) Provide computer-based software designed to store and analyze battery data.
 - a) Provide software capable of compiling reports on individual-cell parameters and total battery performance trends, and of providing data for scheduling and prioritizing battery maintenance.
 - b) Submit documentation and backup copies of the software for storing and analyzing battery data to the Program/Project Manager.
 - b. Performance:
 - 1) Provide monitoring features and components that automatically measure and electronically record the following parameters on a routine schedule and during battery discharge events.
 - a) During discharge events, record measurements timed to the nearest second, including measurements of the following parameters:
 - (1) Total battery voltage and ambient temperature.
 - (2) Individual-cell voltage, impedance, and temperature.
 - (3) During battery-discharging events such as utility outages, measure battery and cell voltages timed to the nearest second.
11. Battery-Cycle Warranty Monitoring Equipment:
- a. Provide an electronic device, acceptable to the battery manufacturer as a basis for warranty action, for monitoring the charge-discharge cycle history of batteries covered by cycle-life warranties.
 - b. Performance:
 - 1) Provide battery-cycle warranty monitoring that automatically measures and records each discharge event, classifies it according to its duration category, totals the discharges according to the warranty criteria, and displays the remaining warranted battery life on the front panel display.
 - c. Provide battery-cycle warranty monitoring that includes the following additional monitoring functions and features:
 - 1) Measuring and Recording:
 - a) Measure and record the total voltage at the battery terminals, and initiate an alarm for excursions outside the proper float-voltage level.
 - (1) Monitors:
 - (a) Measure and record the ambient temperature at the battery, and initiate an alarm if the temperature deviates from the normally acceptable range.
 - (2) Keypad on Device Front Panel:



- (a) Provide a keypad on the device front panel that provides access to the monitored data using front panel display.
- (3) Alarm Contacts:
 - (a) Provide alarm contacts arranged to initiate local or remote alarms for battery discharge events, and abnormal battery voltage or temperature.
- (4) Memory:
 - (a) Provide memory capable of storing the recorded data in nonvolatile electronic memory.
- (5) RS-232 Port:
 - (a) Provide an RS-232 port that permits data to be downloaded to a portable computer.
- (6) Modem:
 - (a) Provide a modem that makes measurements and recorded data accessible to a remote computer via a network connection.

2.02 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. Materials specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.
 - a. Fourteen days before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.

B. Manufacturer Services:

- 1. Equipment Tests:
 - 1) Before shipping the static uninterruptible power supply equipment, have the manufacturer perform the following factory-tests of the complete static uninterruptible power supply manufactured specifically for this Contract:
 - a) Test and demonstration all specified functions, controls, indicators, sensors, and protective devices.
 - b) Run the static uninterruptible power supply at full load.
 - c) Test the transient-load response.
 - d) Perform an overload test.
 - e) Perform a power failure test.
 - 2) Have the manufacturer prepare certified factory test reports documenting the results of the equipment tests, and include the following information in the test reports:
 - a) Description of input source and output loads used.



- b) Description of actions required to simulate source load variation and various operating conditions and malfunctions.
 - c) List of indications, parameter values, and system responses considered satisfactory for each test action, and including a tabulation of the actual observations during test.
 - d) List of instruments and equipment used in factory tests.
 - 3) After the unit has been factory-tested, have the manufacturer submit the factory test reports to the Program/Project Manager for information:
- C. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when switchgear for this Contract are being fabricated and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the static uninterruptible power supply installer present, examine the areas, equipment bases, and conditions where the static uninterruptible power supplies will be installed for compliance with the requirements for installation and other conditions affecting the static uninterruptible power supply performance.
- B. Evaluation and Assessment:
 - 1. Proceed installing the static uninterruptible power supply only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the static uninterruptible power supplies.
- B. Surface Preparation:
 - 1. Concrete Bases:
 - a. Provide flat concrete pads to support the static uninterruptible power supplies.
 - 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the static uninterruptible power supplies.
 - 2) Extend the base no less than 3 inches in all directions beyond the maximum dimensions of the static uninterruptible power supplies,



- unless otherwise indicated on the Contract Drawings, or unless required for seismic anchor support.
- b. Construct the concrete bases in accordance with the seismic-restraint requirements specified in Section 16070, Hangers and Supports.
 - 1) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.
 - c. Place and secure anchorage devices.
 - 1) Design each fastener and support in accordance with the seismic-restraint requirements specified in Section 16071, Seismic Controls, to carry the load indicated by seismic requirements and according to seismic-restraint details.
 - 2) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - 3) Install anchor bolts to the elevations required for proper attachment to the static uninterruptible power supplies.
 - 4) Cast anchor-bolt inserts into the concrete bases.

3.03 INSTALLATION

- A. Equipment Mounting:
 - 1. Install the static uninterruptible power (UPS) supplies on concrete bases.
 - 2. Maintain the minimum clearances and workspace at the equipment in accordance with the requirements specified in NFPA 70 and the manufacturer's written installation instructions.
 - a. Submit the static uninterruptible power supply manufacturer's written installation instructions to the Program/Project manager for information.
- B. Connections:
 - 1. Interconnect the static uninterruptible power (UPS) supply system components.
- C. Special Techniques:
 - 1. Grounding:
 - a. Separately Derived Systems:
 - 1) If the static uninterruptible power (UPS) supply system is not part of a listed power supply for a data-processing room, comply with the requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformers specified in NFPA 70.
 - b. Battery Equalization:



- c. Equalize the charging of the battery cells in accordance with the manufacturer's written instructions.
 - 1) Submit the battery manufacturer's written charging instructions to the Program/Project manager for information.
 - d. Record the individual cell voltages.
 - 1) Submit the individual cell voltages of the batteries to the Program/Project manager for information.
 - 2. Identification:
 - a. Identify field-installed wiring and components and provide warning signs in accordance with the requirements specified in Section 16075, Electrical Identification.
- D. Systems Integration:
- 1. Unless otherwise indicated in the Contract Documents, make the connections to the supply and load circuits in accordance with the manufacturer's wiring diagrams.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
- 1. During the period when static uninterruptible power (UPS) supply system is being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Testing Agency Responsibilities:
 - a. Field Quality-Control Reports:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality Control Report for each test conducted to record the following information pertaining to the test:
 - a) The static uninterruptible power (UPS) supplies included in the testing.
 - b) Test procedures used to perform the testing.



- c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
 - b. Furnish test instruments that have been calibrated within the last 12 months, traceable to standards of the National Institute of Standards and Technology (NIST), and adequate for making positive observation of the test results.
 - 1) Make the calibration records available for examination upon request.
 - c. Test Labeling:
 - 1) Have the Testing Agency attach a label or tag to each tested component indicating satisfactory completion of the tests for that component.
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
 - 3. Performance Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency perform performance tests to verify compliance with the performance requirements specified in Paragraph 2.01.C.
 - 2) Have the Testing Agency document and summarize the test results in a Field Quality Control Performance Test Report.
 - b. Acceptance Criteria:
 - 1) Compare the performance test results with the performance requirements specified herein, and provide justification and resolution of differences if the values do not agree.
 - 4. Inspections:
 - a. Have the Testing Agency perform inspections.
- B. Non-Conforming Work
- 1. Correct deficiencies identified by the tests and observations, and retest the corrected units until the specified requirements are complied with.
 - 2. Remove malfunctioning units, and replace them with conforming replacement units.
 - a. Replace damaged and malfunctioning controls and equipment.
 - b. Retest the replacement units as specified herein.
- C. Manufacturer Services:
- 1. Engage a factory-authorized service representative to inspect the static uninterruptible power (UPS) supply components, connections, and equipment installation, including connections, and to assist in testing.



3.05 SYSTEM STARTUP

A. Commissioning:

1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 16995, Commissioning of Electrical Systems, for the sweep or scheduled lighting controls, daylight dimming controls, lighting occupancy sensors, power quality, security systems, emergency power systems, uninterruptible power supply (UPS) systems, fire and smoke alarms, fire protection systems, communications systems, and public address/paging work pertinent to the Work of this Section.

3.06 ADJUSTING

- #### A. Test and adjust controls and safeties.

3.07 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Training:

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain static uninterruptible power supplies in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- #### A. Take steps to ensure that installed static uninterruptible power supplies are protected during subsequent construction activities.

3.10 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for the static uninterruptible power supplies and accessories for inclusion in emergency and Operation and Maintenance manuals as specified in Section 01780, Closeout Submittals.
2. Submit the operation and maintenance data for the static uninterruptible power supplies and accessories to the Program/Project Manager for information.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16289

TRANSIENT VOLTAGE SUPPRESSION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for field-mounted transient voltage surge suppressors (TVSS) for low-voltage (120 Volt to 600 Volt) power distribution and control equipment.
 - 2. For devices having integral transient voltage surge suppressors (TVSS), refer to Section 16140, Wiring Devices; Section 16441, Switchboards; and Section 16442, Panelboards.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 16080 – Electrical Testing.
 - 5. Section 16140 - Wiring Devices.
 - 6. Section 16441 - Switchboards.
 - 7. Section 16442 - Panelboards.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. SVR: Suppressed voltage rating.
 - 3. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.



2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 - b. IEEE C62.45 - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
6. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA LS 1 – Low-Voltage Surge-Protection (LVSP) Devices.
7. Underwriters Laboratories, Inc. (UL):
 - a. UL 1283 – Standard for Safety for Electromagnetic Interference Filters.
 - b. UL 1449 - Standard for Surge Protective Devices.
 - c. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.
8. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the location of field-mounted transient voltage surge suppression (TVSS) devices with other equipment and the structure to allow adequate clearances for maintenance.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Service entrance suppressors.
 - 2) Panelboard suppressors.
 - 3) Transient voltage surge suppression (TVSS) device enclosures.
 - b. Certificates:



- 1) Manufacturer's Certificates of Compliance for the transient voltage surge suppression (TVSS) devices.
 - c. Qualification Statements:
 - 1) Testing Agency's qualifications.
- B. Informational Submittals:
 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Transient voltage surge suppression (TVSS) device manufacturer's written recommendations and instructions
 - b. Site Quality Control Submittals:
 - 1) Field Quality-Control Report.
 - 2) Factory-authorized service representative report.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the transient voltage surge suppression (TVSS) devices.
 - b. Warranty Documentation:
 - 1) Transient Voltage Surge Suppression (TVSS) Devices Warranty.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish extra replaceable protection modules matching the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) For each size and type of replaceable protection module, provide 1 spare module.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:



- a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET).
- 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

B. Certifications:

1. Electrical Listing and Labeling:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Manufacturer's Certificates of Compliance:
 - a. Submit the transient voltage surge suppression (TVSS) device manufacturer's Certificates of Compliance, certifying that the TVSS devices being provided comply with the specified requirements, to the Program/Project Manager for approval.
 - 1) Include evidence of the complete TVSS devices compliance with the specified performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.



- B. Storage and Handling Requirements:
 - 1. Handle materials and equipment in accordance with the manufacturer's written instructions.
 - 2. Follow the manufacturer's written instructions for storing the items.
- C. Packaging Waste Management:
 - 1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Extended Correction Period:
 - 1. Warrant the transient voltage surge suppression (TVSS) devices' materials and workmanship against failures within the 5 year period after the Date of Substantial Completion:
 - 2. Submit the written Transient Voltage Surge Suppression (TVSS) Devices Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of manufactured transient voltage surge suppression (TVSS) devices that fail in materials or workmanship within the specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 TRANSIENT VOLTAGE SUPPRESSION SYSTEMS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):



- 1) Provide products and installation complying with requirements specified for transient voltage surge suppression (TVSS) devices in NFPA 70.

C. Performance:

1. Service Conditions:

- a. Unless otherwise indicated in the Contract Documents, provide transient voltage surge suppression (TVSS) devices rated for continuous operation under the following conditions:
 - 1) Maximum Continuous Operating Voltage:
 - a) Provide transient voltage surge suppression (TVSS) devices capable of operating at a maximum continuous operating voltage of not less than 115 percent of the nominal system operating voltage.
 - 2) Operating Temperature:
 - a) Provide transient voltage surge suppression (TVSS) devices capable of operating at temperatures of 30 degrees Fahrenheit to 120 degrees Fahrenheit.
 - 3) Humidity:
 - a) Provide transient voltage surge suppression (TVSS) devices capable of operating under conditions of 0 to 85 percent non-condensing relative humidity.
 - 4) Altitude:
 - a) Provide transient voltage surge suppression (TVSS) devices capable of operating at elevations less than 20,000 feet above sea level.

D. Design Criteria:

1. Provide transient voltage surge suppression (TVSS) devices complying with the requirements specified in IEEE C62.41.2, NEMA LS 1, UL 1283, and UL 1449.
2. Product Data:
 - a. Submit Product Data for each type of product indicated to the Program/Project Manager for approval.
 - 1) Include the transient voltage surge suppression (TVSS) devices rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

E. Materials:

1. Service Entrance Suppressors:
 - a. Surge Protection Devices:
 - 1) Provide surge protection devices complying with the requirements specified in UL 1449, and having the following features:
 - a) Non-modular design.
 - b) Fuses rated at 200 kiloamperes interrupting capacity.
 - c) Bolted compression lugs for internal wiring.



- d) Integral disconnect switch.
- e) Redundant suppression circuits.
- f) Redundant replaceable modules.
- g) Arrangement having copper bus bars and bolted connections to phase buses, neutral bus, and ground bus.
- h) Arrangement having wire connections for phase buses, neutral bus, and ground bus.
- i) LED indicator lights for indicating the power and protection status.
- j) An audible alarm, with a silencing switch, to indicate when protection has failed.
- k) Form-C contacts, one normally open and one normally closed, rated at 5 Amperes and 250 Volts AC for remote monitoring of protection status.
 - (1) Provide contacts that reverse on the failure of any surge diversion module, or on the opening of any current-limiting device.
 - (2) Coordinate the requirements for the contacts with the building power monitoring and control system requirements.
- l) A four-digit, transient-event counter set to totalize transient surges.
- b. Peak Single-Impulse Surge Current Rating:
 - 1) Provide service entrance suppressors having a peak single-impulse surge current rating of 160 kiloamperes per mode and 320 kiloamperes per phase.
- c. Minimum Single Impulse Current Ratings:
 - 1) Provide service entrance suppressors having the following minimum single impulse current ratings, using an 8 microsecond by 20 microsecond waveform as described in IEEE C62.41.2.
 - a) Line to Neutral: 70,000 Amperes.
 - b) Line to Ground: 70,000 Amperes.
 - c) Neutral to Ground: 50,000 Amperes.
- d. Protection Modes and Suppressed Voltage Rating (SVR):
 - 1) Provide service entrance suppressors having the following protection modes and suppressed voltage rating (SVR), as defined in UL 1449, for grounded wye circuits having 480Y/277 Volt, 3-phase, 4-wire circuits:
 - a) Line to Neutral: 800 Volts for 480Y/277 Volts.
 - b) Line to Ground: 800 Volts for 480Y/277 Volts.
 - c) Neutral to Ground: 800 Volts for 480Y/277 Volts.
- e. Manufacturers:
 - 1) Raycap – AC Data Solutions, <https://www.raycap.com/surge-protection/dc-protection/ac-data-dc-products/>.
 - 2) Leviton Manufacturing Company, Inc., <http://www.leviton.com>.



- 3) Liebert Corporation; a division of Emerson Network Power,
<https://www.vertivco.com/en-us/products/brands/liebert/>.
- 4) Approved equal.
2. Panelboard Suppressors:
 - a. Surge Protection Devices:
 - 1) Provide surge protection devices complying with the requirements specified in UL 1449, and having the following features:
 - a) Non-modular design.
 - b) A short-circuit current rating complying with the requirements specified in UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits.
 - (1) Provide individually fused metal-oxide varistors.
 - c) Fuses rated at 200 kiloamperes interrupting capacity.
 - d) Bolted compression lugs for internal wiring.
 - e) Integral disconnect switch.
 - f) Redundant suppression circuits.
 - g) Redundant replaceable modules.
 - h) Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - i) LED indicator lights for indicating the power and protection status.
 - j) An audible alarm, with a silencing switch, to indicate when protection has failed.
 - k) Form-C contacts, one normally open and one normally closed, rated at 5 Amperes and 250 Volts AC for remote monitoring of protection status.
 - (1) Provide contacts that reverse on the failure of any surge diversion module, or on the opening of any current-limiting device.
 - (2) Coordinate the requirements for the contacts with the building power monitoring and control system requirements.
 - l) A four-digit, transient-event counter set to totalize transient surges.
 - b. Peak Single-Impulse Surge Current Rating:
 - 1) Provide panelboard suppressors having a peak single-impulse surge current rating of 160 kiloamperes per mode and 320 kiloamperes per phase.
 - c. Minimum Single Impulse Current Ratings:
 - 1) Provide panelboard suppressors having the following minimum single impulse current ratings, using an 8 microsecond by 20 microsecond waveform as described in IEEE C62.41.2.
 - a) Line to Neutral: 70,000 Amperes.
 - b) Line to Ground: 70,000 Amperes.



- c) Neutral to Ground: 50,000 Amperes.
 - d. Protection Modes and Suppressed Voltage Rating (SVR):
 - 1) Provide panelboard suppressors having the following protection modes and suppressed voltage rating (SVR), as defined in UL 1449, for grounded wye circuits having 208Y/120 Volt, 3-phase, 4-wire circuits:
 - a) Line to Neutral: 400 Volts for 208Y/277 Volts.
 - b) Line to Ground: 400 Volts for 208Y/277 Volts.
 - c) Neutral to Ground: 400 Volts for 208Y/277 Volts.
 - e. Manufacturers:
 - 1) Advanced Protection Technologies Inc. (APT), www.apttvss.com.
 - 2) Leviton Manufacturing Company, Inc., <http://www.leviton.com>.
 - 3) Liebert Corporation; a division of Emerson Network Power, <https://www.vertivco.com/en-us/products/brands/liebert/>.
 - 4) Approved equal.
- 3. Enclosures:
 - a. Indoor Enclosures:
 - 1) Provide indoor enclosures complying with the requirements for NEMA Type 1 enclosures specified in NEMA 250.
 - b. Outdoor Enclosures:
 - 1) Provide outdoor enclosures complying with the requirements for NEMA Type 3R enclosures specified in NEMA 250.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the locations to receive the transient voltage surge suppression (TVSS) devices for compliance with requirements affecting performance of the Work.
 - 2. Examine transient voltage surge suppression (TVSS) devices before installation.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 2. Reject transient voltage surge suppression (TVSS) devices that are damaged.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the transient voltage surge suppression (TVSS) devices.



3.03 INSTALLATION

- A. Install transient voltage surge suppression (TVSS) devices in accordance with the manufacturer's written recommendations and installation instructions.
 - 1. Submit the transient voltage surge suppression (TVSS) device manufacturer's written recommendations and installation instructions to the Program/Project Manager for information.
- B. Service Entrance Transient Voltage Surge Suppression (TVSS):
 - 1. Install transient voltage surge suppression (TVSS) devices at service entrances on the load side, with the ground lead bonded to the service entrance ground.
- C. Panelboard and Auxiliary Panel Transient Voltage Surge Suppression (TVSS):
 - 1. Install transient voltage surge suppression (TVSS) devices for panelboards and auxiliary panels so the conductors or buses between the suppressor and the points of attachment are as short and straight as possible.
 - a. Do not exceed the manufacturer's recommended lead length.
 - b. Do not bond the neutral and the ground.
 - 2. Unless otherwise indicated in the Contract Documents, provide multiple, 30 Ampere circuit breakers as a dedicated disconnecting means for the transient voltage surge suppression (TVSS) devices.
- D. Systems Integration:
 - 1. For connecting the transient voltage surge suppression (TVSS) devices to the distribution system, comply with the manufacturer's written recommendation regarding conductor and circuit-breaker sizes.
 - a. Match the circuit-breaker size to the conductor size.
 - b. Coordinate the connections with the requirements shown on the Contract Drawings.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Do not perform insulation resistance tests of the distribution wiring equipment, as specified in Section 16080, Electrical Testing, with the transient voltage surge suppression (TVSS) devices installed.
 - a. Disconnect the TVSS before conducting the insulation resistance tests, and reconnect the TVSS immediately after the testing is over.
 - 2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:



- a) The transient voltage surge suppression (TVSS) devices included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
- 3. Transient Voltage Surge Suppression (TVSS) Test:
 - a. Test Procedure:
 - 1) Test each transient voltage surge suppression (TVSS) device in accordance with the requirements specified in IEEE C62.45.
 - b. Acceptance Criteria:
 - 1) Transient voltage surge suppression (TVSS) devices complying with the requirements acceptance criteria specified in IEEE C62.45 pass the Transient Voltage Surge Suppression (TVSS) Test.
- B. Non-Conforming Work
 - 1. Transient voltage surge suppression (TVSS) devices will be considered to be defective if they do not pass the specified tests and inspections.
- C. Manufacturer Services:
 - 1. Manufacturer's Field Service:
 - a. Engage a factory-authorized service representative to inspect, test, and adjust the transient voltage surge suppression (TVSS) components, assemblies, and equipment installations, including connections.
 - 1) Have the factory-authorized service representative verify the installation of the electrical wiring complies with the manufacturer's written installation requirements.
 - b. Have the factory-authorized service representative submit a report documenting his work to the Program/Project Manager for information.

3.05 SYSTEM STARTUP

- A. Do not energize or connect service entrance equipment or panelboards to their sources until the transient voltage surge suppression (TVSS) devices are installed and connected.

3.06 CLEANING

- A. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



3.07 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to maintain the transient voltage surge suppression (TVSS) devices.

3.08 PROTECTION

- A. Take steps to ensure that installed transient voltage surge suppression (TVSS) devices are protected during subsequent construction activities.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for transient voltage surge suppression (TVSS) devices for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals.
 - 2. Submit the operation and maintenance data for the transient voltage surge suppression (TVSS) devices to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following enclosed switches and circuit breakers, and their enclosures:
 - a. Molded-case switches.
 - 1) Fusible switches.
 - 2) Nonfusible switches.
 - 3) Shunt trip switches.
 - b. Molded-case circuit breakers (MCCBs).
 - c. Enclosures for switches and circuit breakers.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16055 – Overcurrent Protective Device Coordination.
 - 4. Section 16075 – Electrical Identification.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. MCCB: Molded-case circuit breaker.
 - 3. NC: Normally closed.
 - 4. NO: Normally open.
 - 5. NRTL: Nationally Recognized Testing Laboratory.
 - 6. SPDT: Single pole, double throw.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
- C. Reference Standards:



1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME):
 - a. ASME A17.1 - Safety Code for Elevators and Escalators.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
6. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA AB 3 – Molded Case Circuit Breakers and Their Application.
 - c. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
8. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
9. Underwriters Laboratories, Inc. (UL):
 - a. UL 50 – Standard for Enclosures for Electrical Equipment.
 - b. UL 98 – Enclosed and Dead-Front Switches.
 - c. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
10. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Fusible switches.
 - 2) Nonfusible switches.
 - 3) Shunt trip switches.
 - 4) Molded-case circuit breakers.
 - 5) Enclosures.
 - b. Shop Drawings:
 - 1) Enclosed switches and circuit breakers.
 - c. Certificates:
 - 1) Electrical Listing and Labeling.
 - 2) Certification of compliance with the inspection parameters specified in ANSI/NETA ATS.
 - d. Qualification Statements:
 - 1) Qualifications of the Testing Agency.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Site Quality Control Submittals:
 - 1) Calibration record for the infrared scanning device.
 - 2) NETA Acceptance Testing Field Quality Control Report.
 - 3) Infrared Scanning Field Quality Control Report.
 - b. Manufacturer's Reports:
 - 1) Manufacturer's field service report.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for enclosed switches and circuit breakers.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective



covering for storage identified with labels describing the contents of the packages:

- a) Fuses:
 - (1) Furnish a number of fuses for fused switches equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
- b. Tools:
 - 1) Fuse Pullers:
 - a) Provide 2 fuse pullers for each size and type of fuse.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

- 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of enclosed switches and circuit breakers.
- 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

- 1. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with the requirements specified in ANSI/NETA ETT.



- 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Keep each enclosed switch and circuit breaker in its package or otherwise protected until it is time to connect conductors.

PART 2 PRODUCTS

2.01 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Manufacturers:

1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
- 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories within same product category from single source from single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for enclosed switches and circuit breakers in NFPA 70.
- C. Performance:
 - 1. Service Conditions:
 - a. Unless otherwise indicated, provide enclosed switches and circuit breakers rated for continuous operation under the following conditions:
 - 1) Ambient Temperature:
 - a) Not outside the range from 22 degrees Fahrenheit (minus 6 degrees Celsius) to plus 104 degrees Fahrenheit (plus 40 degrees Celsius).
 - 2) Altitude:
 - a) Not exceeding 6600 feet (2000m) above sea level.
- D. Design Criteria:
 - 1. Product Selection for Restricted Space:
 - a. The Contract Drawings indicate the maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures and adjacent surfaces and other items.
 - b. Provide enclosed switches and circuit breakers capable of fitting within the indicated maximum dimensions.
 - 2. Product Data:
 - a. Prepare Product Data for each type of enclosed switch, circuit breaker, accessory, and component indicated in the contract Documents, including dimensioned elevations, sections, weights, and the manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.



- 1) For enclosure types other than NEMA Type 1, indicate the enclosure types and furnish details.
- 2) Include current and voltage ratings.
- 3) Include short-circuit current ratings (interrupting and withstand, as appropriate).
- 4) Include evidence of a Nationally Recognized Testing Laboratory (NRTL) listing for the series rating of installed devices.
- 5) Detail the features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- 6) Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device.
 - a) Include the selectable ranges for each type of overcurrent protective device.
- b. Submit the Product Data for each type of enclosed switch, circuit breaker, accessory, and component to the Program/Project Manager for approval.
3. Shop Drawings:
 - a. Prepare Shop Drawings for enclosed switches and circuit breakers, including plans, elevations, sections, details, and attachments to other work.
 - 1) Wiring Diagrams
 - a) For power, signal, and control wiring furnish wiring diagrams.
 - b. Submit the Shop Drawings for the enclosed switches and circuit breakers to the Program/Project Manager for approval.

E. Materials:

1. Fusible Switches:
 - a. Provide fusible switches having the pole quantities, and voltage and ampere ratings, as indicated on the Contract Drawings.
 - b. Type GD Fusible Switches:
 - 1) Provide general duty, single throw, horsepower rated fusible switches complying with the requirements specified in UL 98 and NEMA KS 1, having cartridge fuse interiors to accommodate the specified fuses, a lockable handle with the capability to accept 2 padlocks, and interlocked with the cover in the closed position.
 - 2) Provide fusible switches rated for 240 Volts AC and 800 Amperes and smaller.
 - 3) Provide fuses having the ampere ratings indicated on the Contract Drawings.
 - c. Type HD Fusible Switches:
 - 1) Provide heavy duty, single throw, horsepower rated fusible switches complying with the requirements specified in UL 98 and NEMA KS 1, having clips or bolt pads to accommodate the specified fuses, a lockable handle with the capability to accept 3 padlocks, and interlocked with the cover in the closed position.



- 2) Provide fusible switches rated for 600 Volts AC and 1200 Amperes and smaller.
- 3) Provide fuses having the ampere ratings indicated on the Contract Drawings.
- d. Accessories:
 - 1) Equipment Ground Kit:
 - a) Provide an internally mounted equipment ground kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum ground conductors.
 - 2) Neutral Kit:
 - a) Provide an internally mounted, insulated neutral kit capable of being grounded and bonded.
 - b) Provide a neutral kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum neutral conductors.
 - 3) Isolated Ground Kit:
 - a) Provide an internally mounted, insulated isolated ground kit capable of being grounded and bonded.
 - b) Provide an internally mounted, insulated isolated ground kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum neutral conductors.
 - 4) Class R Fuse Kit:
 - a) Provide a Class R fuse kit that ensures rejection of other fuse types when Class R fuses are specified.
 - 5) Auxiliary Contact Kit:
 - a) Provide 2 NO/NC (Form "C") auxiliary contact(s), arranged to activate before the switch blades open.
 - 6) Hookstick Handle:
 - a) Provide a handle that allows the use of a hookstick to operate the handle.
 - 7) Lugs:
 - a) Provide compression type lugs, suitable for the number, size, and material of conductors.
 - 8) Service-Rated Switches:
 - a) Provide service-rated switches that are labeled for use as service equipment.
- e. Manufacturers:
 - 1) Eaton Corporation, Cutler-Hammer,
<http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - 2) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - 3) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.schneider-electric.us/>.



- 4) Schneider Electric, Square D, <http://www.schneider-electric.us>.
- 5) Approved equal.
2. Nonfusible Switches:
 - a. Provide nonfusible switches having the pole quantities, and voltage and ampere ratings, as indicated on the Contract Drawings.
 - b. Type GD Nonfusible Switches:
 - 1) Provide general duty, single throw, horsepower rated fusible switches complying with the requirements specified in UL 98 and NEMA KS 1, a lockable handle with the capability to accept 2 padlocks, and interlocked with the cover in the closed position.
 - 2) Provide nonfusible switches rated for 600 Amperes and smaller.
 - c. Type HD Nonfusible Switches:
 - 1) Provide heavy duty, single throw, horsepower rated nonfusible switches complying with the requirements specified in UL 98 and NEMA KS 1, a lockable handle with the capability to accept 3 padlocks, and interlocked with the cover in the closed position.
 - 2) Provide fusible switches rated for 600 Volts AC and 1200 Amperes and smaller.
 - d. Accessories:
 - 1) Equipment Ground Kit:
 - a) Provide an internally mounted equipment ground kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum ground conductors.
 - 2) Neutral Kit:
 - a) Provide an internally mounted, insulated neutral kit capable of being grounded and bonded.
 - b) Provide a neutral kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum neutral conductors.
 - 3) Isolated Ground Kit:
 - a) Provide an internally mounted, insulated isolated ground kit capable of being grounded and bonded.
 - b) Provide an internally mounted, insulated isolated ground kit labeled by a Nationally Recognized Testing Laboratory for copper and aluminum neutral conductors.
 - 4) Auxiliary Contact Kit:
 - a) Provide 2 NO/NC (Form "C") auxiliary contact(s), arranged to activate before the switch blades open.
 - 5) Hookstick Handle:
 - a) Provide a handle that allows the use of a hookstick to operate the handle.
 - 6) Lugs:
 - a) Provide compression type lugs, suitable for the number, size, and material of conductors.
 - e. Manufacturers:



- 1) Eaton Corporation, Cutler-Hammer,
<http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - 2) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - 3) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.siemens.com/us/en/home.html>.
 - 4) Schneider Electric, Square D, <http://www.schneider-electric.us>.
 - 5) Approved equal.
3. Shunt Trip Switches:
- a. Provide shunt trip switches complying with the requirements specified in ASME A17.1, UL 50, and UL 98, and having a 200-kiloampere interrupting and short-circuit current rating when fitted with Class J fuses.
 - b. Switches:
 - 1) Provide three-pole, horsepower rated switches having an integral shunt trip mechanism and a Class J fuse block, a lockable handle with the capability to accept 3 padlocks, and interlocked with the cover in the closed position.
 - c. Control Circuit:
 - 1) Provide switches rated for 120 Volts AC, and having a control power transformer with enough capacity to operate the shunt trip, connected pilot, and indicating and control devices.
 - d. Accessories:
 - 1) Key Switch:
 - a) Provide an oil-tight key switch capable of performing a key-to-test function.
 - 2) Pilot Light:
 - a) Provide an oil-tight green "on" pilot light.
 - 3) Lug:
 - a) Provide an isolated neutral lug having a 100 percent rating.
 - 4) Auxiliary Contacts:
 - a) Provide mechanically interlocked auxiliary contacts that change state when the switch is opened and closed.
 - 5) Contacts:
 - a) Provide Form C alarm contacts that change state when the switch is tripped.
 - e. Manufacturers:
 - 1) Cooper Bussmann, Inc., <http://www.cooperbussmann.com>.
 - 2) Merson Electrical Power, <http://ep-us.mersen.com/>.
 - 3) Littelfuse, Inc., <http://www.littelfuse.com>.
 - 4) Approved equal.
4. Molded-Case Circuit Breakers:



- a. Provide molded-case circuit breakers complying with the requirements specified in UL 489 and NEMA AB 3, and having an interrupting capacity sized to comply with available fault currents.
 - 1) Provide circuit breakers having a standard frame size, trip rating, and number of poles.
 - 2) Shunt Trip:
 - a) Provide circuit breakers having a trip coil energized from a separate circuit, and having a coil-clearing contact.
 - 3) Undervoltage Trip:
 - a) Provide circuit breakers having an undervoltage trip set to operate at 35 to 75 percent of the rated voltage without an intentional time delay.
- b. Thermal-Magnetic Circuit Breakers:
 - 1) Provide thermal-magnetic circuit breakers having an inverse time-current element for low-level overloads, and an instantaneous magnetic trip element for short circuits.
 - 2) Provide an adjustable magnetic trip setting for circuit-breaker frame sizes 250 Amperes and larger.
- c. Application Listing:
 - 1) Provide molded-case circuit breakers having an application listing appropriate for the application;
 - a) For switching fluorescent lighting loads, provide Type SWD circuit breakers.
 - b) For feeding fluorescent and high-intensity discharge lighting circuits, provide Type HID circuit breakers.
- d. Zone-Selective Interlocking:
 - 1) For interlocking the ground-fault protection function, provide zone-selective interlocking integral with the electronic ground-fault trip unit.
- e. Electrical Operator:
 - 1) Provide an electrical operator capable of remotely controlling on, off, and reset operations.
- f. Accessories:
 - 1) Lugs:
 - a) Provide compression type lugs, suitable for the number, size, and material of conductors.
 - 2) Auxiliary Contacts:
 - a) Provide 2 single pole, double throw (SPDT) switches having "a" and "b" contacts that operate as follows:
 - (1) The "a" contacts mimic the circuit-breaker contacts.
 - (2) The "b" contacts operate in reverse of the circuit-breaker contacts.
 - 3) Alarm Switch:
 - a) Provide 1 NO contact that operates only when the circuit breaker has tripped.
 - 4) Key Interlock Kit:



- a) Provide an externally mounted key interlock to prohibit circuit-breaker operation.
 - b) Provide a key that is removable only when circuit breaker is in the "off" position.
- g. Manufacturers:
 - 1) Eaton Corporation, Cutler-Hammer,
<http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - 2) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - 3) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.siemens.com/us/en/home.html>.
 - 4) Schneider Electric, Square D, <http://www.schneider-electric.us>.
 - 5) Approved equal.
- 5. Enclosures:
 - a. Provide enclosures for enclosed switches and circuit breakers complying with the requirements specified in UL 50, UL 489, NEMA 250, and NEMA KS 1 for the environmental conditions at the installed location:

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the enclosed switches and circuit breakers.

3.03 INSTALLATION

- A. When installing enclosed switches and circuit breakers, comply with the requirements specified in NECA 1
 - 1. Unless otherwise indicated in the Contract Documents, install individual wall-mounted switches and circuit breakers with their tops at a uniform height.



- B. Switches:
 - 1. Install fusible and nonfusible switches having the pole quantities, and voltage and ampere ratings indicated on the Contract Drawings.
 - a. For light-commercial applications, provide general duty Type GD fusible or nonfusible switches.
 - b. For all other single-throw switch uses, provide heavy duty Type HD fusible or nonfusible switches.
- C. Install fuses in fusible devices.
- D. Enclosures:
 - 1. Provide enclosures for enclosed switches and circuit breakers complying with the requirements specified in NEMA 250 for the environmental conditions at the installed location:
 - a. For indoor, dry, and clean locations, provide NEMA Type 1 enclosures complying with the requirements specified in NEMA 250.
 - b. For outdoor locations, provide NEMA Type 3R enclosures complying with the requirements specified in NEMA 250.
 - c. For wash-down areas, provide NEMA Type 4X stainless steel enclosures complying with the requirements specified in NEMA 250.
 - d. For other wet or damp indoor locations, provide NEMA Type 4 enclosures complying with the requirements specified in NEMA 250.
- E. Temporary Lifting Provisions:
 - 1. Remove temporary lifting eyes, channels, and brackets, and temporary blocking of moving parts, from the enclosures and components.
- F. Special Techniques:
 - 1. Identification
 - a. Comply with the requirements for identifying electrical equipment specified in Section 16075, Electrical Identification.
 - 1) Identify field-installed conductors, interconnecting wiring, and components.
 - 2) Provide warning signs.
 - 3) Label each enclosure with an engraved metal or laminated-plastic nameplate.
- G. Systems Integration:
 - 1. Coordinate the layout and installation of switches, circuit breakers, and components with the equipment served and adjacent surfaces.
 - a. Maintain the required workspace clearances and required clearances for equipment access doors and panels.

3.04 REPAIR/RESTORATION

A. Malfunctioning Units:



1. Where possible, correct malfunctioning units onsite; and retest the corrected units to demonstrate compliance with the specified requirements.
2. If malfunctioning units cannot be repaired onsite, replace the malfunctioning units with new units, and retest the replacement units.

3.05 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when enclosed switches and circuit breakers are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of enclosed switches and circuit breakers.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The enclosed switches and circuit breakers included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
3. Site Tests:
 - a. NETA Acceptance Testing:
 - 1) Test Procedure:



- a) Have the Testing Agency perform each electrical test specified for enclosed switches and circuit breakers in ANSI/NETA ATS.
 - b) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the enclosed switches and circuit breakers included and documents the NETA Acceptance Testing performed, and submit the report to the Program/Project Manager for information.
 - 2) Acceptance Criteria:
 - a) Have the Testing Agency submit certification of compliance with the test parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
 - b. Infrared Scanning:
 - 1) Test Procedure:
 - a) Instruments and Equipment:
 - (1) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - (2) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
 - b) Initial Infrared Scanning:
 - (1) After Substantial Completion, but not more than 60 days after Final Acceptance, have the Testing Agency perform an infrared scan of each enclosed switch and circuit breaker.
 - (2) Remove the front panels so joints and connections are accessible to the portable infrared scanner.
 - c) Follow-up Infrared Scanning:
 - (1) Have the Testing Agency perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after the date of Substantial Completion.
 - d) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the enclosed switches and circuit breakers included and describes the infrared scanning results, and have the Testing Agency submit the report to the Program/Project Manager for information.
 - 2) Acceptance Criteria:
 - a) Significant deviations from normal temperature values are cause for the enclosed switch or circuit breaker under test to fail the infrared scanning testing.
4. Site Inspections:
 - a. Have the Testing Agency perform each visual and mechanical inspection specified in ANSI/NETA ATS.



- 1) Have the Testing Agency submit certification of compliance with the inspection parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
- B. Non-Conforming Work
 1. Enclosed switches and circuit breakers will be considered defective if they do not pass the tests and inspections specified.
- C. Manufacturer Services:
 1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections; and prepare a manufacturer's field service report.
 2. Submit the manufacturer's field service report to the Program/Project Manager for information.

3.06 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate them as recommended by the manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 16055, Overcurrent Protective Device Coordination.
- C. Test and adjust controls, remote monitoring, and safeties.
 1. Replace damaged and malfunctioning controls and equipment.

3.07 PROTECTION

- A. Take steps to ensure that installed enclosed switches and circuit breakers are protected during subsequent construction activities.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 1. Furnish operation and maintenance data for enclosed switches and circuit breakers for inclusion in emergency manuals and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. The manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device.
 - 1) Include the selectable ranges for each type of overcurrent protective device.
 2. Submit the operation and maintenance data for the enclosed switches and circuit breakers to the Program/Project Manager for information.



END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16420

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of enclosed controllers:
 - a. Full-voltage manual enclosed controllers.
 - b. Full-voltage magnetic enclosed controllers.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 03300 - Cast-in-Place Concrete.
 - 6. Section 16070 – Hangers and Supports.
 - 7. Section 16075 – Electrical Identification.
 - 8. Section 16491 – Fuses.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. CPT: Control power transformer.
 - 3. LED: Light emitting diodes.
 - 4. MCP: Motor circuit protector.
 - 5. NC: Normally closed.
 - 6. NO: Normally open.
 - 7. OCPD: Overcurrent protective device.
 - 8. VA: Voltamperes.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
- C. Reference Standards:



1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. Institute of Electrical and Electronics Engineers (IEEE):
5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
6. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
7. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
8. National Electrical Manufacturers Association (NEMA):
 - a. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
 - b. NEMA ICS 5 - Industrial Control and Systems Control-Circuit and Pilot Devices.
 - c. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
9. U. S. Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the layout and installation of the enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces.
 - a. Maintain the required workspace clearances and required clearances for equipment access doors and panels.



3. Where required for the enclosed controllers, coordinate the sizes and locations of concrete bases with the actual sizes of the equipment provided.
4. Where required for the enclosed controllers, coordinate the sizes and locations of roof curbs, equipment supports, and roof penetrations with the actual sizes and other requirements of the equipment provided.

B. Sequencing:

1. Sequence the installation of concrete bases, roof curbs, equipment supports, and roof penetrations to precede installation of the associated enclosed controllers.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Motor-starting switches.
 - 2) Fractional horsepower manual controllers.
 - 3) Magnetic controllers.
 - 4) Combination magnetic controllers.
 - 5) Enclosures.
 - 6) Control circuit and pilot devices.
 - 7) Auxiliary contacts.
 - 8) Control relays.
 - 9) Phase-failure, phase-reversal, and undervoltage and overvoltage relays.
 - 10) Cover gaskets.
 - 11) Power factor correction capacitor terminals.
 - 12) Control wiring terminal blocks.
 - b. Certificates:
 - 1) Electrical Listing and Labeling.
 - 2) Certification of compliance with the test parameters specified in ANSI/NETA ATS
 - c. Special Procedure Submittals:
 - 1) Load-Current and Overload-Relay Heater List.
 - 2) Load-Current List.
 - 3) List of Settings of Adjustable Overload Relays.
 - d. Qualification Statements:
 - 1) Qualifications of the Testing Agency.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Test and Evaluation Reports:
 - 1) Load-Current and Overload-Relay Heater List.
 - 2) Load-Current List.
 - 3) List of Settings of Adjustable Overload Relays.
 - b. Site Quality Control Submittals:
 - 1) Calibration record for the infrared scanning device.
 - 2) Acceptance Testing Field Quality Control Report.
 - 3) Infrared Scanning Field Quality Control Report.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the enclosed controllers.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Fuses for Fused Switches:
 - (1) Furnish a number of fuses for fused switches equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
 - b) Control Power Fuses:
 - (1) Furnish a number of control power fuses equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
 - c) Indicating Lights:
 - (1) Furnish 2 spare indicating lights of each type and color of installed.
 - d) Auxiliary Contacts:
 - (1) Furnish 1 spare auxiliary contact for each size and type of magnetic controller installed.
 - e) Power Contacts:
 - (1) Furnish 3 spare power contacts for each size and type of magnetic contactor installed.



1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Special Inspections:

- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
- c. Periodic Special Inspections will be performed during the installation of enclosed controllers.

2. Testing and Inspection Agencies:

- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Testing Agency's Qualifications:

- a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT.
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide electrical components, devices, and accessories that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally



recognized testing laboratories are not available or unless standards do not exist for the products.

- 1) Provide products marked with their intended use or classification.
- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 2. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Store the enclosed controllers indoors in a clean, dry space having a uniform temperature to prevent condensation.
 - a. If the enclosed controllers are stored in areas subject to the weather, cover the enclosed controllers to protect them from the weather, dirt, dust, corrosive substances, and physical damage.
 2. Protect the enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Packaging Waste Management:
 1. Remove loose packing and flammable materials from inside the controllers.
 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 ENCLOSED CONTROLLERS

- A. Manufacturers:
 1. Manufacturer List:



- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
- 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for enclosed switches and circuit breakers in NFPA 70.
- C. Performance:
 - 1. Service Conditions:
 - a. Unless otherwise indicated, provide enclosed controllers rated for continuous operation under the following conditions:
 - 1) Ambient Temperature:
 - a) Not outside the range from 22 degrees Fahrenheit (minus 6 degrees Celsius) to plus 104 degrees Fahrenheit (plus 40 degrees Celsius).
 - 2) Altitude:
 - a) Not exceeding 6600 feet (2000m) above sea level.
- D. Design Criteria:
 - 1. Product Data:
 - a. Prepare Product Data for each type of enclosed controller, including the manufacturer's technical data regarding their features, performance, electrical characteristics, ratings, and enclosure types and finishes.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- E. Materials:
 - 1. Full-Voltage Controllers:
 - a. Provide surface mounted, full-voltage controllers complying with the requirements for general purpose, Class A controllers specified in NEMA ICS 2.
 - 1) Provide full-voltage controllers having the pole quantities, voltage rating, NEMA size and type, accessories, short-circuit current



- rating (or available short-circuit currents), and enclosure type indicated on the Contract Drawings.
- b. Motor-Starting Switches:
 - 1) Provide motor-starting switches having "quick-make, quick-break" toggle or push-button action, and that are marked to show whether the unit is off or on.
 - 2) Pilot Light:
 - a) Provide motor-starting switches having a red pilot light.
 - 3) Configuration:
 - a) Provide motor-starting switches having a nonreversing configuration.
 - 4) Manufacturers:
 - a) Eaton Corporation, Cutler-Hammer, <http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - b) General Electric Company; GE Consumer & Industrial - Electrical Distribution, http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - c) Rockwell Automation, Inc., Allen-Bradley, <http://www.ab.com>.
 - d) Siemens Industry, INC., Siemens Energy & Automation, Inc., <https://www.siemens.com/us/en/home.html>.
 - e) Schneider Electric, Square D, <http://www.schneider-electric.us>.
 - f) Approved equal.
 - c. Fractional Horsepower Manual Controllers:
 - 1) Provide surface mounted, fractional horsepower manual controllers having "quick-make, quick-break" toggle or push-button action, and that are marked to show whether the unit is off or on.
 - 2) Configuration:
 - a) Provide fractional horsepower manual controllers having a nonreversing configuration.
 - 3) Overload Relays:
 - a) Provide fractional horsepower manual controllers with bimetallic type overload relays having inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to the nameplate full-load current of the actual protected motor; and an external reset push button.
 - 4) Pilot Light:
 - a) Provide fractional horsepower manual controllers having a red pilot light.
 - 5) Manufacturers:
 - a) Eaton Corporation, Cutler-Hammer, <http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.



- b) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
- c) Rockwell Automation, Inc., Allen-Bradley,
<https://ab.rockwellautomation.com/>.
- d) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.siemens.com/us/en/home.html>.
- e) Schneider Electric, Square D, <http://www.schneider-electric.us>.
- f) Approved equal.
- d. Magnetic Controllers:
 - 1) Provide full voltage, across the line, electrically held magnetic controllers.
 - 2) Configuration:
 - a) Provide magnetic controllers having a nonreversing configuration.
 - 3) Contactor Coils:
 - a) Provide magnetic controllers having pressure-encapsulated type contactor coils.
 - b) Operating Voltage:
 - (1) Depending on NEMA contactor size and the line-voltage rating, provide the manufacturer's standard operating voltage matching the control power or line voltage.
 - 4) Power Contacts:
 - a) Provide totally enclosed, double-break, silver-cadmium oxide; power contacts assembled to allow inspection and replacement of the contacts without disturbing the line or load wiring.
 - 5) Control Circuits:
 - a) Provide control circuits operating on 24 Volts AC obtained from an integral control power transformer (CPT).
 - (1) Provide a control power transformer (CPT) having sufficient capacity to operate the integral devices and remotely located pilot, indicating, and control devices; and having primary and secondary fuses.
 - (2) Provide a control power transformer (CPT) having spare capacity of 50 VA.
 - 6) Solid-State Overload Relay:
 - a) Provide a solid-state overload relay that is switch or dial selectable for motor running overload protection, and that has sensors in each phase, Class 10/20 selectable tripping characteristic selected to protect the motor against a voltage and current unbalance and single phasing, an analog communication module, and Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.



- 7) Manufacturers:
 - a) Eaton Corporation, Cutler-Hammer,
<http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - b) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - c) Rockwell Automation, Inc., Allen-Bradley,
<https://ab.rockwellautomation.com/>.
 - d) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.siemens.com/us/en/home.html>
 - e) Schneider Electric, Square D, <http://www.schneider-electric.us>.
 - f) Approved equal.
- e. Combination Magnetic Controllers:
 - 1) Provide combination magnetic controller consisting of a factory-assembled combination of a magnetic controller, an overcurrent protective device (OCPD), and a disconnecting means.
 - a) The requirements for the disconnecting means and overcurrent protective devices (OCPD) are indicated on the Contract Drawings.
 - 2) Manufacturers:
 - a) Eaton Corporation, Cutler-Hammer,
<http://www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/index.htm>.
 - b) General Electric Company; GE Consumer & Industrial - Electrical Distribution,
http://www.geindustrial.com/cwc/electrical_homepage.htm.
 - c) Rockwell Automation, Inc., Allen-Bradley,
<https://ab.rockwellautomation.com/>.
 - d) Siemens Industry, INC., Siemens Energy & Automation, Inc.,
<https://www.siemens.com/us/en/home.html>
 - e) Schneider Electric, Square D, <http://www.schneider-electric.us>.
 - f) Approved equal.
- f. Enclosures:
 - 1) Provide enclosures for full-voltage controllers complying with the requirements specified in NEMA ICS 6 for the environmental conditions at the installed location:

2.02 ACCESSORIES

A. Control Circuit and Pilot Devices:

1. Unless otherwise indicated, provide control circuit and pilot devices complying with the requirements specified in NEMA ICS 5 and factory-installed in the controller enclosure cover.



- a. Push Buttons:
 - 1) Provide standard-duty, covered type push buttons.
 - 2) Provide maintained push buttons.
 - b. Pilot Lights:
 - 1) Provide standard-duty, LED type pilot lights
 - c. Selector Switches:
 - 1) Provide standard-duty, rotary selector switches.
- B. Auxiliary Contacts:
- 1. Provide normally closed (NC) and normally open (NO) auxiliary contacts as required.
- C. Control Relays:
- 1. Provide auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays:
- 1. Provide relays having a solid-state sensing circuit with isolated output contacts for hard-wired connections.
 - 2. Provide relays having adjustable undervoltage, overvoltage, and time-delay settings.
- E. Cover Gaskets:
- 1. For NEMA Type 1 enclosures, provide cover gaskets.
- F. Power Factor Correction Capacitor Terminals:
- 1. For connecting power factor correction capacitors to the load side of overload relays, provide terminals.
- G. Control Wiring Terminal Blocks:
- 1. Provide the quantity of spare wired, control wiring terminal blocks indicated in the Contract Documents.

2.03 SOURCE QUALITY CONTROL

- A. Non-Conforming Work:
- 1. Do not ship non-conforming units to the Site.
- B. Coordination of Other Tests and Inspections:
- 1. Notify the code-required Approved Agency responsible for performing special inspections when the enclosed controllers for this Contract are being fabricated, installed, and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.



PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. With the installer present, examine elements and surfaces to receive enclosed controllers for compliance with the requirements and other conditions affecting performance of the Work.
 - 2. Before installing the enclosed controllers, examine the enclosed controllers for damage.
 - a. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- B. Evaluation and Assessment:
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the enclosed controllers.
- B. Surface Preparation:
 - 1. Where required for the enclosed controllers, provide concrete bases having a minimum 4-inch (100mm) nominal thickness and that comply with the requirements for concrete bases specified in Section 03300, Cast-in-Place Concrete.
 - 2. Place and secure anchorage devices.
 - a. Cast anchor-bolt inserts into the concrete bases.

3.03 INSTALLATION

- A. When installing enclosed controllers, comply with the requirements specified in NECA 1
- B. Enclosures:
 - 1. Provide enclosures for full-voltage controllers complying with the requirements specified in NEMA ICS 6 for the environmental conditions at the installed location as follows:
 - a. For indoor, dry, and clean locations, provide NEMA Type 1 enclosures complying with the requirements specified in NEMA ICS 6.
 - b. For outdoor locations, provide NEMA Type 3R enclosures complying with the requirements specified in NEMA ICS 6.
 - c. For wash-down areas, provide NEMA Type 4X stainless steel enclosures complying with the requirements specified in NEMA ICS 6.



- d. For other wet or damp indoor locations, provide NEMA Type 4 enclosures complying with the requirements specified in NEMA ICS 6.
- C. Wall-Mounted Controllers:
 - 1. Unless otherwise indicated in the Contract Documents, install individual wall-mounted enclosed controllers with their tops at a uniform height.
 - 2. Bolt the enclosed controllers to the wall, or mount the enclosed controllers on lightweight structural-steel channels bolted to the wall.
- D. Controllers Not at Walls:
 - 1. For controllers not located at walls, provide freestanding racks complying with the requirements specified in Section 16070, Hangers and Supports:
- E. Temporary Lifting Provisions:
 - 1. Remove temporary lifting eyes, channels, and brackets, and temporary blocking of moving parts, from the enclosures and components.
- F. Fuses:
 - 1. Install fuses in each fusible-switch enclosed controller in accordance with the requirements specified in Section 16491, Fuses.
 - 2. If fuses have not been factory-installed in control circuits, install fuses in those circuits in accordance with the requirements specified in Section 16491, Fuses.
- G. Thermal Protection:
 - 1. Install heaters in thermal overload relays.
 - a. Select the heaters after the motors have been installed based on the actual nameplate full-load amperes.
 - 2. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Power Factor Correction:
 - 1. Install power factor correction capacitors connected to the [line][load] side of the overload relays.
 - a. If the power factor correction capacitors are connected to the load side of the overload relays, adjust the overload heater sizes to accommodate the reduced motor full-load currents.
- I. Special Techniques:
 - 1. Identification:
 - a. Identify enclosed controllers, components, and control wiring in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Identify field-installed conductors, interconnecting wiring, and components.



- 2) Provide warning signs complying with the requirements specified in Section 16075, Electrical Identification.
- b. Enclosure Nameplates:
 - 1) Label each enclosure with a nameplate complying with the identification requirements specified in Section 16075, Electrical Identification.
- c. Enclosure-Mounted Controls and Pilot Devices:
 - 1) Label each enclosure-mounted control and pilot device
- d. Device Nameplates:
 - 1) Label each enclosure-mounted control and pilot device in accordance with the identification requirements specified in Section 16075, Electrical Identification.

3.04 REPAIR/RESTORATION

- A. Malfunctioning Units:
 1. Where possible, correct malfunctioning units onsite; and retest the corrected units to demonstrate compliance with the specified requirements.
 2. If malfunctioning units cannot be repaired onsite, replace the malfunctioning units with new units, and retest the replacement units.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when enclosed controllers are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of enclosed controllers.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.



2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The enclosed controllers included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
3. Site Tests:
 - a. Acceptance Testing:
 - 1) Test Procedure:
 - a) Have the Testing Agency perform each electrical test specified for enclosed controllers and their components in ANSI/NETA ATS.
 - b) Have the Testing Agency test the insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - c) Have the Testing Agency test the continuity of each circuit.
 - d) Have the Testing Agency verify that the voltages at the controller locations are within plus or minus 10 percent of the motor nameplate rated voltages.
 - (1) If the voltages at the controller locations are outside this range for any motor, notify the Program/Project Manager before starting the motor(s).
 - e) Have the Testing Agency test each motor for proper phase rotation.
 - f) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the enclosed controllers included and documents the Acceptance Testing performed, and submit the report to the Program/Project Manager for information.
 - 2) Acceptance Criteria:
 - a) Have the Testing Agency submit certification of compliance with the test parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
 - b. Infrared Scanning:
 - 1) Test Procedure:
 - a) Instruments and Equipment:
 - (1) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure



temperature or to detect significant deviations from normal values.

- (2) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
- b) Initial Infrared Scanning:
 - (1) After Substantial Completion, but not more than 60 days after Final Acceptance, have the Testing Agency perform an infrared scan of each multi-pole enclosed controller.
 - (2) Remove the front panels so joints and connections are accessible to the portable infrared scanner.
- c) Follow-up Infrared Scanning:
 - (1) Have the Testing Agency perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after the date of Substantial Completion.
- d) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the enclosed controllers included and describes the infrared scanning results, and have the Testing Agency submit the report to the Program/Project Manager for information.
- 2) Acceptance Criteria:
 - a) Significant deviations from normal temperature values are cause for the enclosed switch or circuit breaker under test to fail the infrared scanning testing.
4. Site Inspections:
 - a. Have the Testing Agency inspect the controllers, wiring, components, connections, and equipment installation.
 - 1) Have the Testing Agency perform each visual and mechanical inspection specified in ANSI/NETA ATS.
 - 2) Have the Testing Agency test and adjust the controllers, components, and equipment.
 - b. Have the Testing Agency submit certification of compliance with the inspection parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.

B. Non-Conforming Work

1. Enclosed controllers will be considered defective if they do not pass the tests and inspections specified herein.

3.06 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. If power factor correction capacitors are connected to the load side of the overload relays, adjust overload-relay heaters or settings.



- C. Adjust the trip settings of motor circuit protectors (MCP) and thermal-magnetic circuit breakers with adjustable instantaneous trip elements.
 - 1. Initially adjust the trip settings to 6 times the motor nameplate full-load ampere ratings, and attempt to start motors several times allowing the motor to cool down between starts.
 - 2. If tripping occurs on motor inrush, adjust the settings in increments until the motors start without tripping.
 - a. Do not exceed 8 times the motor full-load amperes, except 11 times the motor full-load amperes is allowed for NEMA Premium Efficient motors if required.
 - 1) If these maximum settings do not allow a motor to start, notify the Program/Project Manager before increasing the settings.
- D. Test and adjust controls, remote monitoring, and safeties.
 - 1. Replace damaged and malfunctioning controls and equipment.

3.07 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Load-Current and Overload-Relay Heater List:
 - a. After motors have been installed, compile a Load-Current and Overload-Relay Heater List, and arrange a demonstration for the Program/Project Manager to show that the selection of heaters suits the actual motor nameplate full-load currents.
 - b. Submit the Load-Current and Overload-Relay Heater List to the Program/Project Manager for approval.
 - 2. Load-Current List and List of Settings of Adjustable Overload Relays:
 - a. After motors have been installed, compile a Load-Current List and List of Settings of Adjustable Overload Relays, and arrange a demonstration for the Program/Project Manager to show that the switch settings for motor running overload protection suit the actual motors to be protected.
 - b. Submit the Load-Current List and List of Settings of Adjustable Overload Relays to the Program/Project Manager for approval.
- B. Training:
 - 1. Train the Owner's maintenance personnel to adjust, operate, and maintain the enclosed controllers in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.08 PROTECTION

- A. Take steps to ensure that installed enclosed switches and circuit breakers are protected during subsequent construction activities.



3.09 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for enclosed controllers for inclusion in emergency manuals and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. Routine maintenance requirements for enclosed controllers and installed components.
 - b. The manufacturer's written instructions for testing and adjusting the circuit breaker and motor circuit protector (MCP) trip settings.
 - c. The manufacturer's written instructions for setting field-adjustable overload relays.
 - d. The manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
2. Submit the operation and maintenance data for the enclosed controllers to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16424

LOW-VOLTAGE MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:
 - a. Incoming main lugs and OCPDs.
 - b. Full-voltage magnetic controllers.
 - c. Instrumentation.
 - d. Auxiliary devices.

1.02 DEFINITIONS

- A. BAS: Building automation system.
- B. CPT: Control power transformer.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground fault circuit interrupting.
- E. IGBT: Insulated-gate bipolar transistor.
- F. LAN: Local area network.
- G. LED: Light-emitting diode.
- H. MCC: Motor-control center.
- I. MCCB: Molded-case circuit breaker.
- J. MCP: Motor-circuit protector.
- K. NC: Normally closed.
- L. NO: Normally open.
- M. OCPD: Overcurrent protective device.
- N. PCC: Point of common coupling.
- O. PID: Control action, proportional plus integral plus derivative.



- P. PT: Potential transformer.
- Q. TDD: Total demand (harmonic current) distortion.
- R. THD(V): Total harmonic voltage demand.
- S. TVSS: Transient voltage surge suppressor.

1.03 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Functional Features
 - a) Controller units.
 - b) Feeder tap units.
 - c) Future units.
 - d) Spare units.
 - 2) Incoming Mains
 - a) Thermal magnetic circuit breakers.
 - b) MCCB features and accessories.
 - 3) Combination Controllers
 - a) Full voltage controllers.
 - b) Disconnecting means and OCPDs.
 - c) Overload relays.
 - d) Control circuits.
 - 4) MCC Control Power
 - a) Control circuits.
 - b) Control power fuses.
 - c) Control wiring.
 - 5) Enclosures
 - a) Indoor enclosures.
 - b) Enclosure finish for indoor units.
 - c) Compartments.
 - d) Wiring spaces.
 - 6) Auxiliary Devices
 - a) Push buttons.
 - b) Pilot lights.
 - c) Selector switches.
 - d) Reversible NC/NO contactor auxiliary contact(s).
 - e) Control relays.
 - f) Phase-Failure, Phase-Reversal, and Undervoltage and Over-voltage Relays.
 - g) Cover gaskets for Type 1 enclosures.



- h) Terminals for connecting power factor correction capacitors to the load side of overload relays.
 - i) Spare control-wiring terminal blocks; unwired.
 - j) Spare-fuse cabinet.
 - b. Shop Drawings:
 - 1) For each MCC, manufacturer's approval and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 2) Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a) Each installed unit's type and details.
 - b) Factory-installed devices.
 - c) Enclosure types and details.
 - d) Nameplate legends.
 - e) Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
 - f) Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
 - g) Specified optional features and accessories.
 - 3) Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
 - 4) Nameplate legends.
 - 5) Vertical and horizontal bus capacities.
 - 6) Features, characteristics, ratings, and factory settings of each installed unit.
 - c. Standard Drawings: For each MCC, as defined in UL 845.
 - d. Production Drawings: For each MCC, as defined in UL 845.
 - 1) Product Certificates:
 - a) For each MCC, from manufacturer.
 - e. Qualification Statements:
 - 1) Qualified testing agency.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Source Quality Control Submittals:
 - 1) Source quality-control reports.
 - b. Site Quality Control Submittals:
 - 1) Field quality-control reports.
- C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1) Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
 - 2) Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3) Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4) Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
 - 5) Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 6) Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - 7) Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - 8) Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
 - b. Warranty Documentation:
 - 1) Sample of special warranty.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.



- E. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
- B. Handle MCCs according to the following:
 - 1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
 - 2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
- C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

1.07 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.
- C. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.



1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. ABB; Control Products.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Industrial Systems.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845.

2.02 FUNCTIONAL FEATURES

- A. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.
- B. Controller Units: Combination controller units.
 - 1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - 2. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.



- C. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
- D. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- E. Spare Units: Installed in compartments indicated "spare."

2.03 INCOMING MAINS

- A. Incoming Mains Location: Verify in the field.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads.
 - d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.04 COMBINATION CONTROLLERS

- A. Full-Voltage Controllers:
 - 1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
 - 2. Magnetic Controllers: Full voltage, across the line, electrically held.
 - a. Configuration: Nonreversing.
- B. Disconnecting Means and OCPDs:
 - 1. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
- C. Overload Relays:



1. Solid-State Overload Relays:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 1) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 2) Analog communication module.
2. NC and NO isolated overload alarm contact.
3. External overload reset push button.

D. Control Power:

1. Control Circuits: 24 ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50 VA.

2.05 MCC CONTROL POWER

- A. Control Circuits: 24-V dc.
- B. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.06 ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- C. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
- D. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.



E. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

2.07 AUXILIARY DEVICES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, oiltight type.
 - a. Push Buttons: Unguarded types; maintained contact unless otherwise indicated.
 - b. Pilot Lights: LED types; push to test.
 - c. Selector Switches: Rotary type.

B. Reversible NC/NO contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

E. Cover gaskets for Type 1 enclosures.

F. Terminals for connecting power factor correction capacitors to the load side of overload relays.

G. Spare control-wiring terminal blocks; unwired.

H. Spare-Fuse Cabinet: Identified cabinet with hinged lockable door.

2.08 CHARACTERISTICS AND RATINGS

A. Wiring: NEMA ICS 18, Class I, Type A or Type B, for starters above Size 3 Type C.

B. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

C. Nominal System Voltage: 480 V, three phase, three wire.

D. Short-Circuit Current Rating for Each Unit: Fully rated; 42 kA.



- E. Environmental Ratings:
 - 1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
 - 2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.
 - 3. Humidity Rating: Less than 95 percent (noncondensing).
 - 4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
- F. Main-Bus Continuous Rating: As seen on drawings.
- G. Vertical-Bus Continuous Rating: Match main-bus rating.
- H. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.
- I. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
- J. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
- K. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy.
- L. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables.
- M. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors.
- N. Front-Connected, Front-Accessible MCCs:
 - 1. Main Devices: Fixed mounted.
 - 2. Controller Units: fixed mounted.
 - 3. Feeder-Tap Units: fixed mounted.
 - 4. Sections front and rear aligned.
- O. Ammeters, Voltmeters, and Power-Factor Meters:
 - 1. Provide ammeters, voltmeters, and power-factor meters complying with the requirements specified in ANSI C39.1.
 - 2. Meters:
 - a. Provide 4-inch diameter or 6 inches square, flush or semiflush, meters with antiparallax 250-degree scales and external zero adjustment.
 - 3. Voltmeters:



- a. Provide voltmeters that cover an expanded-scale range of the nominal voltage plus 10 percent.
- 4. Software and Hardware:
 - a. Provide software and hardware that is compatible with that specified in Section 13453, Supervisory Control and Data Acquisition (SCADA).
- P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.
- Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.
- R. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.09 SOURCE QUALITY CONTROL

- A. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.
- B. MCCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required work-space clearances and required clearances for equipment access doors and panels.



- B. Floor-Mounting Controllers: Install MCCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 3 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible switch.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 16 Section "Fuses."
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
- I. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Division 16 Section "Electrical Identification" for identification of MCC, MCC components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label MCC and each cubicle with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
 - 4. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.



- B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.04 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central-control system. Comply with requirements in Division 16 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 CONNECTIONS

- A. Comply with requirements for installation of conduit in Section 16130, Raceways and Boxes. The Contract Drawings indicate general the arrangement of conduit, fittings, and specialties.
- B. Comply with requirements in Section 16060, Grounding and Bonding.

3.06 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).



5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
10. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

C. Enclosed controllers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.08 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.



- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

3.09 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16441

SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following switchboards and associated equipment:
 - a. Service and distribution switchboards rated at 600 Volts and less.
 - b. Transient voltage suppression devices.
 - c. Disconnecting and overcurrent protective devices.
 - d. Instrumentation.
 - e. Control power.
 - f. Accessory components and features.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03300 – Cast-In-Place Concrete.
 - 5. Section 13453, Supervisory Control and Data Acquisition (SCADA)
 - 6. Section 16055 – Overcurrent Protective Device Coordination.
 - 7. Section 16075 – Electrical Identification.
 - 8. Section 16134 - Cable Trays.
 - 9. Section 16450 - Enclosed Bus Assemblies.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. DC: Direct electrical current.
 - 2. HVAC: Heating, Ventilating, and Air-Conditioning.
 - 3. MCCB: Molded-case circuit breakers.
 - 4. NRTL – Nationally Recognized Testing Laboratory.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.



C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
 - b. IEEE C62.41.1 – IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
5. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
6. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
7. National Electrical Contractors Association (NECA):
 - a. ANSI/NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
 - b. ANSI/NECA 400 - Standard for Installing and Maintaining Switchboards.
8. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA EI 21.1 - Instrument Transformers for Revenue Metering (110 kV BIL and Less).
 - c. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - d. NEMA PB 2 - Deadfront Distribution Switchboards.
9. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 70E - Standard for Electrical Safety in the Workplace®.
10. Underwriters Laboratories, Inc. (UL):
 - a. UL 891 - Switchboards.
 - b. UL 1449 - Standard for Surge Protective Devices.
11. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:



1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
2. Coordinate the layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.
 - a. Maintain required workspace clearances and required clearances for equipment access doors and panels.
3. Coordinate the sizes and locations of concrete bases with the actual equipment provided.

B. Sequencing:

1. Provide concrete bases and anchorage devices prior to installing the switchboards.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Switchboards.
 - 2) Transient voltage suppression devices.
 - 3) Molded-case circuit breakers (MCCB).
 - 4) Instrument transformers.
 - 5) Ammeters, voltmeters, and power-factor meters.
 - b. Shop Drawings:
 - 1) Switchboards and related equipment.
 - 2) Setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices.
 - c. Certificates:
 - 1) Electrical listing and labeling.
 - d. Qualification Statements:
 - 1) Switchboard installer's qualifications.
 - 2) Testing Agency's qualifications.

B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's installation, operation, and starting instructions for the switchboard equipment and systems.
 - b. Site Quality Control Submittals:
 - 1) Field Quality-Control Report for Insulation Resistance Tests.
 - 2) Field Quality-Control Report for Electrical Continuity Tests.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the switchboards and components.
 - b. Warranty Documentation:
 - 1) Switchboard Warranty.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective covering for storage identified with labels describing the contents of the packages:
 - a) Potential Transformer Fuses:
 - (1) Furnish a number of fuses for potential transformer equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
 - b) Control-Power Fuses:
 - (1) Furnish a number of fuses for control power equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of



Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.

- c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
- 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

- 1. Switchboard Installer's Qualifications:
 - a. Only employ a switchboard installer that employs workers who are qualified as defined in NEMA PB 2.1, and who are trained in electrical safety as required by NFPA 70E.
 - b. Submit the switchboard installer's qualifications to the Program/Project Manager for approval.
- 2. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET).
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

- 1. Electrical Listing and Labeling:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.



- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Do not deliver switchboards until the spaces are enclosed and weathertight, the wet work in the spaces is complete and dry, the Work above where the switchboards will be installed is complete, and a temporary heating, ventilating, and air-conditioning (HVAC) system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Deliver switchboards in sections or lengths that are capable of being moved past obstructions within the delivery path.
 3. Receive and inspect switchboards in accordance with the requirements specified in ANSI/NECA 400.
- B. Storage and Handling Requirements:
 1. Handle, store, and prepare switchboards for installation in accordance with the requirements specified in ANSI/NECA 400.
 2. Prevent condensation in the switchboards.
- C. Packaging Waste Management:
 1. Remove loose packing and flammable materials from inside the switchboards.
 2. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Do not install switchboards in spaces until the spaces are enclosed and weathertight, all wet work in the spaces is complete and dry, work above the switchboards is complete, and a temporary heating ventilating and air conditioning (HVAC) system is operating and maintaining the ambient



temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.08 WARRANTY

- A. Extended Correction Period:
 - 1. Warrant the transient voltage suppression devices' materials and workmanship against failures within the 5 year period after the Date of Substantial Completion:
 - 2. Submit the written Switchboard Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 SWITCHBOARD EQUIPMENT

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Eaton Electrical Inc., Cutler-Hammer, www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/Index.htm.
 - b. Square D; Schneider Electric, www.schneider-electric.us/square-d-home-page.
 - c. General Electric, G.E., www.ge.com
 - d. Approved equal.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:
 - 1) Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Description:
 - 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
 - b. National Electrical Code (NEC):



- 1) Provide products and installation complying with requirements specified for switchboards in NFPA 70.

C. Design Criteria:

1. Switchboards:
 - a. Provide switchboards complying with the requirements specified in NEMA PB 2 and UL 891.
2. Service Conditions:
 - a. Provide switchboards complying with the requirements specified in NEMA PB 1 for usual service conditions.
 - b. Unless otherwise indicated, provide switchboard equipment rated for continuous operation under the following conditions:
 - 1) Ambient Temperature:
 - a) Not exceeding 130 degrees Fahrenheit).
 - 2) Altitude:
 - a) Not exceeding 1500 feet above sea level.
3. Product Selection for Restricted Space:
 - a. The Contract Drawings indicate the maximum dimensions for switchboards, including clearances between switchboards and adjacent surfaces and other items.
 - b. Provide switchboards capable of fitting within the indicated maximum dimensions.
4. Product Data:
 - a. For each type of switchboard, switching and overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated in the Contract Documents, submit Product Data to the Program/Project Manager for approval.
 - 1) Include dimensions and the manufacturers' technical data on the features, performance, electrical characteristics, ratings, and finishes of their products.
5. Shop Drawings:
 - a. For each switchboard and related equipment, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Include dimensioned plans, elevations, sections, and details.
 - a) Show required clearances and service space around the switchboard equipment.
 - b) Show tabulations of installed devices, equipment features, and ratings.
 - 2) Detail enclosure types and details for types other than NEMA Type 1, which is described and specified in NEMA 250.
 - 3) Detail the bus configuration, current, and voltage ratings.
 - 4) Detail the short-circuit current rating of the switchboards and overcurrent protective devices.
 - 5) Include descriptive documentation of barriers specified for electrical insulation and isolation.



- 6) Detail the utility company's metering provisions, with an indication of approval by utility company.
- 7) Include evidence of a Nationally Recognized Testing Laboratory (NRTL) listing for series rating of installed devices.
- 8) Detail the features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 9) Include schematic and wiring diagrams for power, signal, and control wiring.
- 10) Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
 - a) Submit the time-current coordination curves on translucent log-log graft paper
 - b) Include selectable ranges for each type of overcurrent protective device.
- 11) Include a diagram and details of the proposed mimic bus.

D. Materials:

1. Switchboards:

- a. Provide front-connected, front-accessible switchboards assembled as follows:
 - 1) Main Devices: Panel mounted.
 - 2) Branch Devices: Panel mounted.
 - 3) Sections front and rear aligned.
- b. Nominal System Voltage:
 - 1) Provide switchboards designed for a nominal system voltage of 480Y/277 Volts.
- c. Main-Bus Continuous:
 - 1) Provide a switchboard main-bus as indicated on the Contract Drawings.
- d. Outdoor Enclosures:
 - 1) Provide outdoor enclosures having a flat roof, and complying with the requirements for NEMA Type 3R enclosures, which are described and specified in NEMA 250.
 - 2) Finish:
 - a) Provide outdoor enclosures having a factory-applied finish in the manufacturer's standard color.
 - b) Treat the undersurfaces of the outdoor enclosures with a corrosion-resistant undercoating.
- e. Insulation and Isolation:
 - 1) Provide insulation and isolation for the main bus of the main section and for the main and vertical buses of feeder sections.
- f. Utility Metering Compartment:
 - 1) Provide a fabricated utility metering barrier compartment and section complying with the utility company's requirements.
 - a) Provide a hinged sealed door.



- b) Provide buses provisioned for mounting the utility company's current transformers and potential transformers or potential taps as required by the utility company.
- 2) If a separate vertical section is required for utility metering, match and align this section with the basic switchboard.
- 3) Provide a service entrance label, and applicable service entrance features.
- g. Bus Transition and Incoming Pull Sections:
 - 1) Provide bus transition and incoming pull sections matched and aligned with the basic switchboard.
- h. Hinged Front Panels:
 - 1) Provide hinged front panels that allow access to the circuit breaker, metering, accessory, and blank compartments.
- i. Buses and Connections:
 - 1) Unless otherwise indicated, provide three phase, four wire buses and connections.
 - 2) Phase- and Neutral-Bus Material:
 - a) Provide phase- and neutral-buses fabricated from silver-plated, hard-drawn copper of 98 percent conductivity, and having tin-plated aluminum or copper feeder circuit-breaker line connections.
 - 3) Load Terminals:
 - a) Provide load terminals consisting of insulated, rigidly braced, runback bus extensions, fabricated from the same material as the through buses, and equipped with compression connectors for outgoing circuit conductors.
 - b) Provide load terminals for future circuit-breaker positions at the full-ampere rating of the circuit-breaker position.
 - 4) Ground Bus:
 - a) Provide a ground bus of the minimum-size required by UL 891, fabricated from hard-drawn copper of 98 percent conductivity, and equipped with compression connectors for feeder and branch-circuit ground conductors.
 - b) For busway feeders, extend insulated equipment grounding cable to the busway ground connection, and support the cable at intervals in the vertical run.
 - 5) Main Phase Buses and Equipment Ground Buses:
 - a) Provide main phase buses and equipment ground buses having a uniform capacity for entire length of the switchboard's main and distribution sections.
 - b) Provide main phase buses and equipment ground buses for future extensions from both ends.
 - 6) Neutral Buses:
 - a) Unless otherwise indicated, provide neutral buses having 100 percent of the ampacity of the phase buses and equipped with compression connectors for outgoing circuit neutral cables.



- b) Brace bus extensions for the busway feeder neutral bus.
 - 7) Isolation Barrier Access Provisions:
 - a) Provide isolation barrier access provisions that permit bus-bolt tightness to be checked.
 - j. Future Devices:
 - 1) Equip compartments with mounting brackets, supports, bus connections, and appurtenances at the full rating of circuit-breaker compartment to accommodate future devices.
 - k. Bus-Bar Insulation:
 - 1) Provide bus-bar insulation consisting of factory-applied, flame-retardant, tape wrapping on individual bus bars; or flame-retardant, spray-applied insulation.
 - 2) Provide bus-bar insulation having a minimum insulation temperature rating of 105 degrees Celsius.
- 2. Transient Voltage Suppression Devices:
 - a. Surge Protection Devices:
 - 1) Provide integrally mounted, parallel-connected, wired-in solid-state, non-modular type surge protection devices complying with the requirements specified in IEEE C62.41 and the second edition of UL 1449, and having the following features and accessory items
 - a) Provide sine-wave tracking suppression and filtering modules.
 - b) Provide a short-circuit current rating matching or exceeding the switchboard short-circuit rating.
 - c) Provide fuses rated at 200kA interrupting capacity.
 - d) Provide bolted compression lugs for internal wiring.
 - e) Provide an integral disconnect switch.
 - f) Provide redundant suppression circuits.
 - g) Provide an arrangement which provides wire connections to the phase buses, neutral bus, and ground bus.
 - h) Provide LED indicator lights that indicate power and protection status.
 - i) Provide an audible alarm with a silencing switch to indicate when protection has failed.
 - j) Provide Form-C contacts rated at 5 Amperes and 250 Volts AC, one normally open and one normally closed, for remote monitoring of system operation.
 - (1) Provide contacts that reverse position on the failure of any surge diversion module, or on the opening of any current-limiting device.
 - (2) Coordinate remote monitoring of the system operation with the building power monitoring and control system.
 - k) Provide a four-digit, transient-event counter set to totalize transient surges.
 - b. Peak Single-Impulse Surge Current Rating:



- 1) Provide surge protection devices having a peak single-impulse surge current rating of 160 kA per mode/320 kA per phase.
- 1) Provide surge protection devices having the withstand capability to withstand 12,000 Category C3 (10 kA), 8-by-20- microsecond surges, as described in IEEE C62.41, while allowing less than a 5 percent change in the clamping voltage.
- 2) Provide surge protection devices having protection modes, and a suppressed voltage rating (SVR) as specified in the second edition of UL 1449, for grounded wye circuits with 480Y/277-Volt, three-phase, four-wire circuits as follows:
 - a) Line to Neutral: 800 Volts for 480Y/277.
 - b) Line to Ground: 800 Volts for 480Y/277.
 - c) Neutral to Ground: 800 Volts for 480Y/277
3. Disconnecting and Overcurrent Protective Devices:
 - a. Molded-Case Circuit Breakers (MCCB):
 - 1) Provide molded-case circuit breakers (MCCB) complying with the requirements specified in UL 489, with an interrupting capacity to meet available fault currents, and having the following features and accessories:
 - a) Provide the standard frame sizes, trip ratings, and number of poles.
 - b) Provide Compression style lugs suitable for the trip ratings, conductor material and size, and the number of conductors.
 - c) Provide an application listing appropriate for the application as follows:
 - (1) For switching fluorescent lighting loads, provide Type SWD.
 - (2) For feeding fluorescent and high-intensity discharge (HID) lighting circuits, provide Type HID.
 - d) Provide ground-fault protection consisting of an integrally mounted relay and trip unit with adjustable pickup and time-delay settings, a push-to-test feature, and a ground-fault indicator.
 - e) Provide zone-selective interlocking integral with the electronic trip unit for interlocking the ground-fault protection function.
 - f) Provide a shunt trip consisting of a 120-Volt trip coil energized from a separate circuit, and set to trip at 55 percent of the rated voltage.
 - g) Provide an undervoltage trip set to operate at 35 to 75 percent of the rated voltage without an intentional time delay.
 - 2) Current-Limiting Circuit Breakers:
 - a) Provide current-limiting circuit breakers having 400 Ampere and smaller frame sizes, and let-through ratings less than RK-5 as defined in NEMA FU 1.
 - 3) Ground Fault Circuit Interrupter (GFCI) Circuit Breakers:



- a) Provide ground fault circuit interrupter (GFCI) circuit breakers having single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 4) Ground-Fault Equipment Protection (GFEP) Circuit Breakers:
 - a) Provide ground-fault equipment protection (GFEP) circuit breakers having Class B ground-fault protection (30mA trip).
- 4. Instrumentation:
 - a. Instrument Transformers:
 - 1) Provide instrument transformers complying with the requirements specified in IEEE C57.13, NEMA EI 21.1, and the following:
 - a) Current Transformers:
 - (1) Provide wound type current transformers complying with the requirements specified in IEEE C57.13, and having a 5 Ampere, 60 Hertz secondary.
 - (2) Provide current transformers having a single secondary winding and a secondary shorting device.
 - (3) Provide current transformers having a burden and accuracy consistent with the connected metering and relay devices.
 - b) Control-Power Transformers:
 - (1) Provide dry type control-power transformers, and for units larger than 3 kVA mounted in separate compartments.
 - c) Current Transformers for Neutral and Ground-Fault Current Sensing:
 - (1) For neutral and ground-fault current sensing, connect the secondary wiring of current transformers to ground overcurrent relays, via shorting terminals, to provide selective tripping of the main and tie circuit breaker.
 - (2) Coordinate current transformers provided for neutral and ground-fault current sensing with the feeder circuit-breaker and ground-fault protection.
 - b. Ammeters, Voltmeters, and Power-Factor Meters:
 - 1) Provide ammeters, voltmeters, and power-factor meters complying with the requirements specified in ANSI C39.1.
 - 2) Meters:
 - a) Provide 4-inch diameter or 6 inches square, flush or semiflush, meters with antiparallax 250-degree scales and external zero adjustment.
 - 3) Voltmeters:
 - a) Provide voltmeters that cover an expanded-scale range of the nominal voltage plus 10 percent.
 - 4) Software and Hardware:
 - a) Provide software and hardware that is compatible with that specified in Section 13453, Supervisory Control and Data Acquisition (SCADA).



5. Control Power:
 - a. Control Circuits:
 - 1) Provide 24-Volt DC control circuits.
 - b. Control Wiring:
 - 1) Provide factory-installed control wiring, with bundling, lacing, and protection included.
 - 2) Provide flexible conductors for 8 AWG and smaller conductors, for conductors across hinges, and for conductors for interconnections between shipping units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the elements and surfaces to receive switchboards for compliance with the installation tolerances and other conditions affecting performance of the Work.
 2. Examine switchboards before installation.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
 2. Reject switchboards that are moisture damaged or physically damaged.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the switchboards.
- B. Surface Preparation:
 1. Provide concrete bases having a minimum 4-inch (100mm) nominal thickness and that comply with the requirements for concrete bases specified in Section 03300, Cast-in-Place Concrete, for the switchboards.
 - a. Install dowel rods to connect the concrete base to the concrete floor beneath.
 - b. Unless otherwise indicated in the Contract Documents, install dowel rods around the full perimeter of the concrete base on 18-inch (450mm) centers.
 2. Place and secure anchorage devices.
 - a. Install anchor bolts to the elevations required for proper attachment to the switchboards.
 - 1) Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded to properly locate these items.



- 2) Cast anchor-bolt inserts into the concrete bases.
 - 3) For supported equipment, install epoxy-coated anchor bolts that extend through the concrete base, and anchor into the structural concrete floor beneath.
 - b. Submit the setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices to the Program/Project Manager for information.
- C. Demolition / Removal:
- 1. Installation Pathway:
 - a. Remove and replace access fencing, doors, lift-out panels, and structures to provide a pathway for moving switchboards into place.

3.03 INSTALLATION

- A. When installing switchboards, comply with the requirements specified in ANSI/NECA 1, ANSI/NECA 400, and NFPA 70E.
- B. Equipment Mounting:
 - 1. Install switchboards on concrete bases.
- C. Temporary Lifting Provisions:
 - 1. Remove temporary lifting eyes, channels, and brackets, and temporary blocking of moving parts, from the switchboard units and components.
- D. Connections:
 - 1. Terminate feeder bus in accordance with the requirements specified in Section 16450, Enclosed Bus Assemblies.
 - a. The Contract Drawings indicate the general arrangement of the bus, fittings, and specialties.
 - 2. Terminate cable trays in accordance with the requirements specified in Section 16134, Cable Trays.
 - a. The Contract Drawings indicate the general arrangement of the cable trays, fittings, and specialties.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Operating Instructions:
 - 1. Provide printed basic operating instructions for the switchboards, including control and key interlocking sequences and emergency procedures, framed and mounted on the front of the switchboards.
 - a. Fabricate the frame from finished wood or metal, and provide a clear acrylic plastic protective cover for the instructions.



H. Special Techniques:

1. Identification:

- a. Identify field-installed conductors, interconnecting wiring, and components in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Provide warning signs complying with the requirements specified in Section 16075, Electrical Identification.
- b. Switchboard Nameplates:
 - 1) Label each switchboard compartment with a nameplate complying with the identification requirements specified in Section 16075, Electrical Identification.
- c. Device Nameplates:
 - 1) Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with the identification requirements specified in Section 16075, Electrical Identification.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

- 1. During the period when switchboards are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of switchboards.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- 2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The switchboards included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.



- d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
- 3. Insulation Resistance Test:
 - a. Test Procedure:
 - 1) For each switchboard bus, component, connecting supply, feeder, and control circuit, test the insulation resistance.
 - 2) Prepare a certified Field Quality-Control Report that identifies the switchboards included and documents the Insulation Resistance Tests, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Switchboards buses, components, connecting supply, feeders, and control circuits having insulation sufficient for the wiring installation to be free from short circuits and from grounds pass the Insulation Resistance Test.
 - a) These items will be considered defective if they do not pass the specified test.
- 4. Electrical Continuity Test:
 - a. Test Procedure:
 - 1) Test the electrical continuity of each circuit.
 - 2) Prepare a certified Field Quality-Control Report that identifies the switchboards included and documents the Continuity Tests, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Circuits displaying electrical discontinuities fail the Electrical Continuity Test
- 5. Infrared Scanning:
 - a. Test Procedure:
 - 1) Instruments and Equipment:
 - a) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - b) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
 - 2) Initial Infrared Scanning:
 - a) Two months after Substantial Completion, have the Testing Agency perform an infrared scan of the transformer connections.
 - 3) Follow-up Infrared Scanning:
 - a) Have the Testing Agency perform 2 additional follow-up infrared scans of each transformer, the first follow-up scan 4



- months after the date of Substantial Completion, and the second follow-up scan 7 months after the first follow-up scan.
- 4) Have the Testing Agency prepare a certified Infrared Scanning Field Quality-Control Report that identifies the transformers included and describes the infrared scanning results, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Significant deviations from normal temperature values are cause for the transformer under test to fail the infrared scanning testing.
 - 2) Test Labeling:
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
 6. Inspections:
 - a. Inspect the switchboards in accordance with the requirements specified in ANSI/NECA 400.
 - B. Non-Conforming Work
 1. Switchboards will be considered defective if they do not pass the specified inspections and tests.
 2. Where possible, correct malfunctioning units onsite, and retest the corrected units to demonstrate compliance with the specified requirements; otherwise, replace malfunctioning units with new units and retest the replacement units.
 - C. Manufacturer Services:
 1. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.05 SYSTEM STARTUP

- A. Prior to starting switchboard equipment or systems, obtain and review the manufacturer's installation, operation, and starting instructions.
 1. Submit the manufacturer's installation, operation, and starting instructions for the switchboard equipment and systems to the Program/Project Manager for information.
- B. Set field-adjustable, circuit-breaker trip ranges in the coordination report developed as the Work of Section 16055, Overcurrent Protective Device Coordination.
- C. Verify the correctness of the wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.



3.06 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate them as recommended by manufacturer.

3.07 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Train the Owner's maintenance personnel to adjust, operate, and maintain the switchboards, overcurrent protective devices, instrumentation, and accessories.

3.08 PROTECTION

- A. Take steps to insure that installed switchboards are protected during subsequent construction activities.

3.09 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for switchboards and components for inclusion in emergency and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. Routine maintenance requirements for switchboards and installed components.
 - b. The overcurrent protective device manufacturer's written instructions for testing and adjusting these devices.
 - c. Time-current curves for each type and rating of overcurrent protective device included in the switchboards, including selectable ranges for each type of overcurrent protective device that allows adjustments.
 - 2. Submit the operation and maintenance data for the switchboards and components to the Program/Project Manager for information.
 - a. Submit the time-current coordination curves on translucent log-log graph paper

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16442

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of panelboards:
 - a. Distribution panelboards.
 - b. Lighting and appliance branch-circuit panelboards.
 - c. Electronic-grade panelboards.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 03300 - Cast-in-Place Concrete.
 - 4. Section 13453 - Supervisory Control and Data Acquisition (SCADA).
 - 5. Section 16055 - Overcurrent Protective Device Coordination.
 - 6. Section 16071 - Seismic Controls.
 - 7. Section 16075 - Electrical Identification.
 - 8. Section 16491 - Fuses.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. AFCI: Arc-Fault Circuit-Interrupter.
 - 3. GFCI: Ground Fault Circuit Interrupter.
 - 4. GFEP: Ground Fault Equipment Protection.
 - 5. HVAC: Heating Ventilating and Air Conditioning.
 - 6. LED: Light emitting diodes.
 - 7. MCCB: Molded-case circuit breakers.
 - 8. NRTL: Nationally Recognized Testing Laboratory.
 - 9. RMS: Root-mean-square.
 - 10. SVR: Suppressed voltage rating.
 - 11. TVSS: Transient voltage surge suppressor.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in



29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.

C. Reference Standards:

1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 344 - IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.
 - b. IEEE C62.41. – IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - c. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
6. National Electrical Contractors Association (NECA):
 - a. NECA 1 - Standard Practice of Good Workmanship in Electrical Contracting.
 - b. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards.
7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA PB 1 – Panelboards.
 - c. NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
 - a. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
 - b. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - c. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
8. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 70E - Standard for Electrical Safety in the Workplace®.
9. Underwriters Laboratories, Inc. (UL):
 - a. UL 67 – Standard for Panelboards.



- b. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - c. UL 1449 - Standard for Surge Protective Devices.
 - d. UL 1699 - Standard for Safety for Arc-Fault Circuit-Interrupters.
 - e. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories>.
10. United States Government:
- a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
- 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.
 - 2. Coordinate the layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.
 - a. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 3. Coordinate the sizes and locations of concrete bases for freestanding panelboards with the actual equipment provided.
- B. Sequencing:
- 1. For floor mounted panelboards, provide concrete bases and anchorage devices prior to installing the panelboards.

1.04 SUBMITTALS

- A. Action Submittals:
- 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Distribution panelboards.
 - 2) Lighting and appliance branch-circuit panelboards.
 - 3) Load centers.
 - 4) Electronic-grade panelboards.
 - 5) Molded-case circuit breakers (MCCB).
 - 6) Fused switches.



- 7) Surge protection devices.
 - 8) Accessory set.
 - 9) Portable test set.
 - b. Shop Drawings:
 - 1) Panelboards and related equipment.
 - 2) Setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices.
 - 3) Panelboard schedules.
 - c. Certificates:
 - 1) Electrical Listing and Labeling.
 - 2) Seismic Qualification Certificates.
 - 3) Certification of compliance with the inspection parameters specified in ANSI/NETA ATS.
 - d. Qualification Statements:
 - 1) Testing Agency's qualifications.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's installation, operation, and starting instructions for the panelboard equipment and systems.
 - b. Site Quality Control Submittals:
 - 1) Calibration record for the infrared scanning device.
 - 2) Insulation Resistance Tests Field Quality-Control Report.
 - 3) Electrical Continuity Tests Field Quality-Control Report.
 - 4) NETA Acceptance Testing Field Quality-Control Report.
 - 5) Infrared Scanning Field Quality-Control Report.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the panelboards and components.
 - b. Warranty Documentation:
 - 1) Panelboards Warranty.
- D. Maintenance Material Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare parts that match the products installed in the following quantities, and package the spare parts with a protective



covering for storage identified with labels describing the contents of the packages:

- a) Keys:
 - (1) Furnish 2 spare keys for each type of panelboard cabinet lock.
 - b) Circuit Breakers:
 - (1) Furnish 2 spare circuit breakers, including GFCI and Ground Fault Equipment Protection (GFEP) types, for each panelboard.
 - c) Fuses for Fused Switches:
 - (1) Furnish a number of fuses for fused switches equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
 - d) Fuses for Fused Power-Circuit Devices:
 - (1) Furnish a number of fuses for fused power-circuit devices equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
- b. Tools:
- 1) Accessory set.
 - 2) Portable test set.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

- 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of medium-voltage wire, cable, and accessories.
- 2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

- 1. Testing Agency's Qualifications:



- a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET).
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Electrical Listing and Labeling:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
 - 2. Seismic Qualification Certificates:
 - a. Have the manufacturer prepare Seismic Qualification Certificates certifying that the panelboards, overcurrent protective devices, accessories, and components will withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.



- 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
- b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Receive, inspect, handle, and store panelboards in accordance with the requirements specified in NECA 407 or NEMA PB 1.1.
- B. Storage and Handling Requirements:
 1. Remove loose packing and flammable materials from the inside of the panelboards.
 2. Handle and prepare panelboards for installation in accordance with the requirements specified in NECA 407 or NEMA PB 1.1.

1.07 SITE CONDITIONS

- A. Ambient Conditions:
 1. Do not deliver or install panelboards in spaces until the spaces are enclosed and weathertight, all wet work in the spaces is complete and dry, work above the panelboards is complete, and a temporary heating ventilating and air conditioning (HVAC) system is operating and maintaining the ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Existing Conditions:
 1. Interruption of Existing Electric Service:
 - a. Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electric service according to the requirements indicated:
 - 1) Notify the Program/Project Manager no fewer than 2 days in advance of the proposed interruption of electric service.
 - 2) Do not interrupt electric service without the Program/Project Manager's written permission.

1.08 WARRANTY

- A. Extended Correction Period:
 1. Warrant the panelboards' materials and workmanship against failures within the 5 year period after the Date of Substantial Completion:
 2. Submit the written Panelboards Warranty on the manufacturer's standard form in which the manufacturer agrees to repair or replace components of



manufactured panelboards that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.

- a. Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 PANELBOARD EQUIPMENT

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.

2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- b. Source Limitations:
 - 1) Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Description:

1. Regulatory Requirements:

- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for panelboards in NFPA 70.

C. Performance:

1. Seismic Performance:

- a. Provide panelboards capable of withstanding the effects of earthquake motions determined in accordance with the procedures specified in ASCE/SEI 7.
 - 1) The phrase "capable of withstanding" is hereby defined to mean the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
- b. Fabricate and test panelboards in accordance with the requirements specified in IEEE 344 to withstand the seismic forces defined in Section 16071, Seismic Controls.

D. Design Criteria:



1. Panelboards:
 - a. Provide panelboards complying with the requirements specified in NEMA PB 1 and NFPA 70.
 - b. Provide distribution panelboards complying with the requirements specified in NFPA 70 for power panelboards.
2. Service Conditions:
 - a. Provide panelboards complying with the requirements specified in NEMA PB 1 for usual service conditions.
 - b. Unless otherwise indicated, provide panelboard equipment rated for continuous operation under the following conditions:
 - 1) Ambient Temperature:
 - a) Not outside the range from 23 degrees Fahrenheit (minus 5 degrees Celsius) to plus 104 degrees Fahrenheit (plus 40 degrees Celsius).
 - 2) Altitude:
 - a) Not exceeding 1500 feet above sea level.
3. Product Selection for Restricted Space:
 - a. The Contract Drawings indicate the maximum dimensions for panelboards, including clearances between panelboards and adjacent surfaces and other items.
 - b. Provide panelboards capable of fitting within the indicated maximum dimensions.
4. Enclosures:
 - a. Provide flush- and surface mounted cabinets rated for the environmental conditions at the installed location as follows:
 - 1) Indoor Dry and Clean Locations:
 - a) Provide NEMA Type 1, which is described and specified in NEMA 250.
 - 2) Outdoor Locations:
 - a) Provide NEMA Type 3R, which is described and specified in NEMA 250.
 - 3) Kitchen and Wash-Down Areas:
 - a) Provide NEMA Type 4X, which is described and specified in NEMA 250.
 - 4) Other Wet or Damp Indoor Locations:
 - a) Provide NEMA Type 4, which is described and specified in NEMA 250.
 - 5) Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids:
 - a) Provide NEMA Type 5, which is described and specified in NEMA 250.
 - b. Front:
 - 1) Provide fronts secured to the box with concealed trim clamps.
 - 2) For surface-mounted fronts, match the box dimensions.
 - 3) For flush-mounted fronts, overlap the box.
 - c. Hinged Front Cover:



- 1) Provide a front cover having the entire front trim hinged to the box, and having a standard door within the hinged trim cover.
 - d. Skirt for Surface-Mounted Panelboards:
 - 1) Provide a skirt for surface-mounted panelboards of the same gage and finish as the panelboard front, and having flanges for attachment to the panelboard, wall, and ceiling or floor.
 - e. Gutter Extension and Barrier:
 - 1) Provide a gutter extension and barrier of the same gage and finish as the panelboard enclosure, and integral with the enclosure body.
 - 2) Arrange the gutter extension and barrier so individual panel sections are isolated.
 - f. Directory Card:
 - 1) Provide a directory card inside the panelboard door, mounted in a metal frame with a transparent protective cover.
5. Incoming Main Locations:
 - a. Verify entry locations for incoming mains as required.
6. Phase, Neutral, and Ground Buses:
 - a. Provide tin-plated aluminum phase, neutral, and ground buses.
 - b. Equipment Ground Bus:
 - 1) Provide an equipment ground bus adequate to accommodate the feeder and branch-circuit equipment grounding conductors.
 - 2) Bond the equipment ground bus to the box.
 - c. Isolated Ground Bus:
 - 1) Provide an isolated ground bus adequate to accommodate the branch-circuit isolated ground conductors.
 - 2) Insulate the isolated ground bus from the box.
 - d. Extra-Capacity Neutral Bus:
 - 1) Provide an extra-capacity neutral bus rated 200 percent of the phase bus, and UL-listed as suitable for nonlinear loads.
 - e. Split Bus:
 - 1) Provide vertical buses divided into individual vertical sections.
7. Conductor Connectors:
 - a. Provide tin-plated aluminum conductor connectors suitable for use with the conductor material and sizes.
 - b. Main and Neutral Lugs:
 - 1) Provide mechanical type main and neutral lugs.
 - c. Ground Lugs and Bus-Configured Terminators:
 - 1) Provide mechanical type ground lugs and bus-configured terminators.
 - d. Feed-Through Lugs:
 - 1) Provide mechanical type feed-through lugs, suitable for use with the conductor material.
 - 2) Locate the feed-through lugs at the opposite end of the bus from incoming lugs or the main device.
 - e. Subfeed (Double) Lugs:



- 1) Provide mechanical type subfeed (double) lugs suitable for use with the conductor material.
 - 2) Locate the subfeed (double) lugs at the same end of the bus as incoming lugs or the main device.
- f. Gutter-Tap Lugs:
 - 1) Provide mechanical type gutter-tap lugs suitable for use with conductor material.
 - 2) Locate gutter-tap lugs at the same end of the bus as incoming lugs or the main device.
- g. Extra-Capacity Neutral Lugs:
 - 1) Provide extra-capacity neutral lugs rated 200 percent of the phase lugs mounted on the extra-capacity neutral bus.
8. Service Equipment Label:
 - a. Provide service equipment labeled by a nationally recognized testing laboratory (NRTL) for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
9. Future Devices:
 - a. Provide mounting brackets, bus connections, filler plates, and necessary appurtenances required for the future installation of devices.
10. Panelboard Short-Circuit Current Rating:
 - a. Provide panelboards fully rated to interrupt symmetrical short-circuit current available at the terminals.
11. Product Data:
 - a. For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated in the Contract Documents, submit Product Data to the Program/Project Manager for approval.
 - 1) Include dimensions and the manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes of their products.
12. Shop Drawings:
 - a. For each panelboard and related equipment, submit Shop Drawings to the Program/Project Manager for approval.
 - 1) Include dimensioned plans, elevations, sections, and details.
 - a) Show tabulations of installed devices, equipment features, and ratings.
 - 2) Detail enclosure types and details for types other than NEMA Type 1, which is described and specified in NEMA 250.
 - 3) Detail the bus configuration, current, and voltage ratings.
 - 4) Indicate the short-circuit current rating of the panelboard and overcurrent protective devices.
 - 5) Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.



- 6) Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 7) Include wiring diagrams for power, signal, and control wiring.
- 8) Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
 - a) Submit the time-current coordination curves on translucent log-log graft paper
 - b) Include selectable ranges for each type of overcurrent protective device.

E. Materials:

1. Distribution Panelboards:

a. Panelboards:

- 1) Provide power and feeder distribution type panelboards complying with the requirements specified in NEMA PB 1.

b. Doors:

- 1) Provide doors secured with a vault-type latch with a tumbler lock.
- 2) For doors more than 36 inches (914mm) high, provide 2 latches, keyed alike.
- 3) Key the door latches alike.

c. Mains:

- 1) Provide mains having circuit breakers only.

d. Branch Overcurrent Protective Devices:

- 1) For circuit-breaker frame sizes 125 Amp and smaller, provide Bolt-on circuit breakers.

e. Contactors in Main Bus:

- 1) In the main bus, provide general-purpose controller, mechanically held, contactors complying with the requirements for Class A contactors as specified in NEMA ICS 2, and having the same short-circuit interrupting rating as the panelboard.
 - a) Provide the contactor connections, contactor types, quantity of circuits controlled, current ratings, external control circuits, and number of poles as indicated on the Contract Drawings and schedules.
- 2) Internal Control-Power Source:
 - a) Provide a control-power transformer, with fused primary and secondary terminals, connected to the main bus ahead of the contactor connection.
 - (1) Provide a control-power transformer having the capacity and associated fuses indicated on the Contract Drawings.

f. Manufacturers:

- 1) Eaton Electrical Inc., Cutler-Hammer,
www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/Index.htm.



- 2) Square D; Schneider Electric, www.schneider-electric.us/square-d-home-page.
 - 3) General Electric, G.E., www.ge.com
 - 4) Approved equal.
2. Lighting and Appliance Branch-Circuit Panelboards:
- a. Panelboards:
 - 1) Provide lighting and appliance branch-circuit type panelboards complying with the requirements specified in NEMA PB 1.
 - b. Mains:
 - 1) Provide mains having circuit breakers only.
 - c. Branch Overcurrent Protective Devices:
 - 1) Provide bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - d. Contactors in Main Bus:
 - 1) In the main bus, provide general-purpose controller, mechanically held, contactors complying with the requirements for Class A contactors as specified in NEMA ICS 2, and having the same short-circuit interrupting rating as the panelboard.
 - a) Provide the contactor connections, contactor types, quantity of circuits controlled, current ratings, external control circuits, and number of poles as indicated on the Contract Drawings and schedules.
 - 2) Internal Control-Power Source:
 - a) Provide a control-power transformer, with fused primary and secondary terminals, connected to the main bus ahead of the contactor connection.
 - (1) Provide a control-power transformer having the capacity and associated fuses indicated on the Contract Drawings.
 - e. Doors:
 - 1) Provide doors having concealed hinges, and secured with a flush latch with a tumbler lock.
 - 2) Key the door latches alike.
 - f. Column-Type Panelboards:
 - 1) Provide column-type panelboards having a narrow gutter extension with a cover to an overhead junction box equipped with ground and neutral terminal buses.
 - g. Manufacturers:
 - 1) Eaton Electrical Inc., Cutler-Hammer, www.eaton.com/EatonCom/ProductsServices/Cutler-Hammer/Index.htm.
 - 2) Square D; Schneider Electric, www.schneider-electric.us/square-d-home-page.



- 3) General Electric, G.E., www.ge.com
- 4) Approved equal.
3. Electronic-Grade Panelboards:
 - a. Panelboards:
 - 1) Provide electronic-grade panelboards complying with the requirements specified in NEMA PB 1, having a factory-installed, integral transient voltage surge suppressor (TVSS), and labeled by a nationally recognized testing laboratory (NRTL) for compliance with UL 67 after the transient voltage surge suppressor (TVSS) has been installed.
 - b. Doors:
 - 1) Provide doors secured with a vault-type latch with a tumbler lock.
 - 2) Key the door latches alike.
 - c. Main Overcurrent Protective Devices:
 - 1) Provide bolt-on thermal-magnetic circuit breakers on mains.
 - d. Branch Overcurrent Protective Devices:
 - 1) Provide bolt-on thermal-magnetic circuit breakers on branch circuits.
 - e. Buses:
 - 1) Provide copper phase and neutral buses; having 200 percent capacity neutral bus and lugs.
 - 2) Provide copper equipment and isolated ground buses.
 - f. Surge Protection Device:
 - 1) Provide modular (with field-replaceable modules) type surge protection devices having sine-wave tracking suppression and filtering modules.
 - 2) Provide surge protection devices having a short-circuit current rating complying with the requirements specified in the second edition of UL 1449 and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.
 - 3) Provide integrally mounted, parallel-connected, bolt-on, solid-state surge protection devices complying with the requirements specified in IEEE C62.41, and including the following accessory items:
 - a) Provide fuses rated at 200kA interrupting capacity.
 - b) Provide bolted compression lugs for internal wiring.
 - c) Provide an integral disconnect switch.
 - d) Provide redundant suppression circuits.
 - e) Provide redundant replaceable modules.
 - f) Provide an arrangement which provides wire connections to the phase buses, neutral bus, and ground bus.
 - g) Provide LED indicator lights that indicate power and protection status.



- h) Provide an audible alarm with a silencing switch to indicate when protection has failed.
 - i) Provide Form-C contacts rated at 5 Amperes and 250 Volts AC, one normally open and one normally closed, for remote monitoring of system operation.
 - (1) Provide contacts that reverse position on the failure of any surge diversion module, or on the opening of any current-limiting device.
 - (2) Coordinate remote monitoring of the system operation with the building power monitoring and control system.
 - j) Provide a four digit, transient-event counter set to totalize transient surges.
- 4) Provide surge protection devices having a peak single-impulse surge current rating of 80 kA per mode/160 kA per phase.
 - 5) Provide surge protection devices having the minimum single-impulse current ratings, using an 8-by-20-microsecond waveform as described in IEEE C62.41.2, as follow:
 - a) Line to Neutral: 70,000 Amperes.
 - b) Line to Ground: 70,000 Amperes.
 - c) Neutral to Ground: 50,000 Amperes.
 - 6) Provide surge protection devices having the withstand capability to withstand 12,000 Category C3 (10 kA), 8-by-20- microsecond surges, as described in IEEE C62.41, while allowing less than a 5 percent change in the clamping voltage.
 - 7) Provide surge protection devices having protection modes, and a suppressed voltage rating (SVR) as specified in the second edition of UL 1449, for grounded wye circuits for 208Y/120 Volt, three-phase, four-wire circuits as follows:
 - a) Line to Neutral: 400 Volts for 208Y/120.
 - b) Line to Ground: 400 Volts for 208Y/120.
 - c) Neutral to Ground: 400 Volts for 208Y/120.
 - 8) Provide surge protection devices having protection modes, and a suppressed voltage rating (SVR) as specified in the second edition of UL 1449, for 480 Volt, three-phase, three-wire, delta circuits as follow:
 - a) Line to Line: 2000 Volts for 480 Volts.
 - b) Line to Ground: 1500 Volts for 480 Volts.
- g. Manufacturers:
 - 1) Current Technology; a subsidiary Thomas & Betts Power Solutions, LLC, <https://currenttechnology.com>.
 - 2) Cutler-Hammer, Eaton Electrical Inc., www.eaton.com/EatonCom/Markets/Electrical/.
 - 3) Liebert Corporation, an Emerson Network Power Company, <https://www.vertivco.com/en-us/products/brands/liebert/>.



- 4) Siemens Energy and Automation, Inc.,
<https://www.industry.usa.siemens.com/>.
 - 5) Square D; a brand of Schneider Electric, www.schneider-electric.us.
 - 6) Approved equal.
4. Disconnecting and Overcurrent Protective Devices:
- a. Molded-Case Circuit Breaker (MCCB):
 - 1) Provide molded-case circuit breakers (MCCB) complying with the requirements specified in UL 489, with an interrupting capacity to meet available fault currents, and having the following features and accessories:
 - a) Provide the standard frame sizes, trip ratings, and number of poles.
 - b) Provide Mechanical style lugs suitable for the trip ratings, conductor material and size, and the number of conductors.
 - c) Provide an application listing appropriate for the application as follows:
 - (1) Type SWD for switching fluorescent lighting loads.
 - (2) Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d) Provide ground-fault protection consisting of an integrally mounted relay and trip unit with adjustable pickup and time-delay settings, a push-to-test feature, and a ground-fault indicator.
 - e) Provide communication capability consisting of a circuit-breaker-mounted communication module with functions and features compatible with the power monitoring and control system specified in Section 13453, Supervisory Control and Data Acquisition (SCADA).
 - f) Provide a shunt trip consisting of a 120 Volt trip coil energized from a separate circuit, and set to trip at 75 percent of the rated voltage.
 - g) Provide an undervoltage trip set to operate at 35 to 75 percent of the rated voltage without an intentional time delay.
 - h) Provide auxiliary contacts consisting of two SPDT switches having "a" and "b" contacts, where "a" contacts mimic the circuit-breaker contacts and "b" contacts operate in reverse of the circuit-breaker contacts.
 - i) Provide an alarm switch consisting of a single-pole, normally open contact that actuates only when the circuit breaker trips.
 - j) Provide a key interlock kit externally mounted to prohibit circuit-breaker operation, and having a key removable only when the circuit breaker is in off position.



- k) Provide zone-selective interlocking integral with the electronic trip unit for interlocking the ground-fault protection function with other upstream or downstream devices.
 - l) Provide multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - m) Provide a handle padlocking device, consisting of a fixed attachment, for locking the circuit-breaker handle in the on or off position.
 - n) Provide a handle clamp consisting of a loose attachment for holding the circuit-breaker handle in the on position.
- 2) Thermal-Magnetic Circuit Breakers:
 - a) Provide thermal-magnetic circuit breakers having an inverse time-current element for low-level overloads, and an instantaneous magnetic trip element for short circuits.
 - b) Provide an adjustable magnetic trip setting for circuit-breaker frame sizes 250 Amperes and larger.
- 3) Thermal-Magnetic Circuit Breakers:
 - a) Provide thermal-magnetic circuit breakers having a magnetic trip element with a front-mounted, field-adjustable trip setting.
- 4) Provide electronic trip circuit breakers having rms sensing, a field-replaceable rating plug or field-replicable electronic trip, and the following field-adjustable settings:
 - a) Instantaneous trip.
 - b) Long- and short-time pickup levels.
 - c) Long- and short-time time adjustments.
 - d) Ground-fault pickup level, time delay, and I^2t response.
- 5) Current-Limiting Circuit Breakers:
 - a) Provide current-limiting circuit breakers having 400 Ampere and smaller frame sizes, and let-through ratings less than RK-5 as defined in NEMA FU 1.
- 6) Ground Fault Circuit Interrupter (GFCI) Circuit Breakers:
 - a) Provide ground fault circuit interrupter (GFCI) circuit breakers having single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 7) Ground-Fault Equipment Protection (GFEP) Circuit Breakers:
 - a) Provide ground-fault equipment protection (GFEP) circuit breakers having Class B ground-fault protection (30-mA trip).
- 8) Arc-Fault Circuit-Interrupter (AFCI) Circuit Breakers:
 - a) Provide 120/240-Volt, single-pole arc-fault circuit interrupter (AFCI) circuit breakers complying with the requirements specified in UL 1699.
- b. Fused Switches:
 - 1) Provide a Type HD fused switch complying with the requirements specified in NEMA KS 1, and having the following features and accessories:



- a) Clips to accommodate the specified fuses, and a lockable handle.
 - b) Standard number of poles and ampere ratings.
 - c) Two normally open and normally closed auxiliary contacts that operate with switch handle operation.
 - 2) Fuses, and Spare-Fuse Cabinet:
 - a) Provide fuses and a spare-fuse cabinet complying with the requirements specified in Section 16491, Fuses.
 - c. Manufacturers:
 - 1) Cutler-Hammer, Eaton Electrical Inc., www.eaton.com/EatonCom/Markets/Electrical/.
 - 2) Siemens Energy and Automation, Inc., <https://www.industry.usa.siemens.com/>.
 - 3) Square D; a brand of Schneider Electric, www.schneider-electric.us.
 - 4) Approved equal.
- 5. Panelboard Suppressors:
 - a. Surge Protection Device:
 - 1) Provide integrally mounted, parallel-connected, solid-state surge protection devices complying with the requirements specified in IEEE C62.41, and including the following accessory items:
 - a) Provide LED indicator lights that indicate the power and protection status.
 - b) Provide an audible alarm with a silencing switch that indicates when protection has failed.
 - c) Provide 1 set of dry contacts rated at 5 Amperes and 250-Volts AC, for remote monitoring of the protection status.
 - b. Surge Protection Device:
 - 1) Provide modular (with field-replaceable modules) type surge protection devices having sine-wave tracking suppression and filtering modules.
 - 2) Provide surge protection devices having a short-circuit current rating complying with the requirements specified in the second edition of UL 1449 and matching or exceeding the panelboard short-circuit rating.
 - 3) Provide integrally mounted, parallel-connected, bolt-on, solid-state surge protection devices complying with the requirements specified in IEEE C62.41, and including the following accessory items:
 - a) Provide fuses rated at 200kA interrupting capacity.
 - b) Provide bolted compression lugs for internal wiring.
 - c) Provide an integral disconnect switch.
 - d) Provide redundant suppression circuits.
 - e) Provide redundant replaceable modules.



- f) Provide an arrangement which provides wire connections to the phase buses, neutral bus, and ground bus.
 - g) Provide LED indicator lights that indicate power and protection status.
 - h) Provide an audible alarm with a silencing switch to indicate when protection has failed.
 - i) Provide Form-C contacts rated at 5 Amperes and 250 Volts AC, one normally open and one normally closed, for remote monitoring of system operation.
 - (1) Provide contacts that reverse position on the failure of any surge diversion module, or on the opening of any current-limiting device.
 - (2) Coordinate remote monitoring of the system operation with the building power monitoring and control system.
 - j) Provide a four digit, transient-event counter set to totalize transient surges.
- 4) Provide surge protection devices having a peak single-impulse surge current rating of 80 kA per mode/160 kA per phase.
 - 5) Provide surge protection devices having the minimum single-impulse current ratings, using an 8-by-20-microsecond waveform as described in IEEE C62.41.2, as follow:
 - a) Line to Neutral: 70,000 Amperes.
 - b) Line to Ground: 70,000 Amperes.
 - c) Neutral to Ground: 50,000 Amperes.
 - 6) Provide surge protection devices having the withstand capability to withstand 12,000 Category C3 (10 kA), 8-by-20- microsecond surges, as described in IEEE C62.41, while allowing less than a 5 percent change in the clamping voltage.
 - 7) Provide surge protection devices having protection modes, and a suppressed voltage rating (SVR) as specified in the second edition of UL 1449, for grounded wye circuits with 480Y/277 Volt, three-phase, four-wire circuits as follows:
 - a) Line to Neutral: 800 Volts for 480Y/277.
 - b) Line to Ground: 800 Volts for 480Y/277.
 - c) Neutral to Ground: 800 Volts for 480Y/277.
 - 8) Provide surge protection devices having protection modes, and a suppressed voltage rating (SVR) as specified in the second edition of UL 1449, for 480 Volt, three-phase, three-wire, delta circuits as follow:
 - a) Line to Line: 2000 Volts for 480 Volts.
 - b) Line to Ground: 1500 Volts for 480 Volts.
- c. Manufacturers:
 - 1) Current Technology; a subsidiary Thomas & Betts Power Solutions, LLC, <https://currenttechnology.com>.
 - 2) Cutler-Hammer, Eaton Electrical Inc., www.eaton.com/EatonCom/Markets/Electrical/.



- 3) Liebert Corporation, an Emerson Network Power Company, <https://www.vertivco.com/en-us/products/brands/liebert/>.
- 4) Siemens Energy and Automation, Inc., <https://www.industry.usa.siemens.com/>.
- 5) Square D; a brand of Schneider Electric, www.schneider-electric.us.
- 6) Approved equal.

F. Finishes:

1. Panels and Trim:
 - a. Immediately after cleaning and pretreating steel panels and trim, factory-finish the panels and trim with the manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
2. Back Boxes:
 - a. Provide back boxes having the same finish as the panels and trim.
3. Fungus Proofing:
 - a. Provide permanent fungicidal treatment for overcurrent protective devices and other components.

2.02 ACCESSORIES

A. Accessory Set:

1. Provide an accessory set that include the tools and miscellaneous items required for overcurrent protective device tests, inspections, maintenance, and operation.

B. Portable Test Set:

1. Provide a portable test set for testing the functions of solid-state trip devices without the necessity of removing them from the panelboard.
 - a. Include relay and meter test plugs suitable for testing the panelboard meters and switchboard class relays.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Examine the elements and surfaces to receive panelboards for compliance with the installation tolerances and other conditions affecting performance of the Work.
2. Examine panelboards before installation.

B. Evaluation and Assessment:

1. Proceed with installation only after unsatisfactory conditions have been corrected.



2. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the panelboards.
- B. Surface Preparation:
 1. For floor mounted panelboards, provide concrete bases having a minimum 4-inch (100mm) nominal thickness and that comply with the requirements for concrete bases specified in Section 03300, Cast-in-Place Concrete.
 - a. Install dowel rods to connect the concrete base to the concrete floor beneath.
 - b. Unless otherwise indicated in the Contract Documents, install dowel rods around the full perimeter of the concrete base on 18-inch (450mm) centers.
 2. For floor mounted panelboards, install anchor bolts to the elevations required for proper attachment to the panelboards.
 - a. Place and secure anchorage devices.
 - 1) Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded to properly locate these items.
 - 2) Cast anchor-bolt inserts into the concrete bases.
 - 3) Install epoxy-coated anchor bolts that extend through the concrete base, and anchor into the structural concrete floor beneath.
 - b. Submit the setting drawings, templates, diagrams, instructions, and directions for placing and securing anchorage devices to the Program/Project Manager for information.

3.03 INSTALLATION

- A. When installing panelboards, comply with the requirements specified in NECA 1, NECA 407, NEMA PB 1.1, and NFPA 70E.
- B. Equipment Mounting:
 1. Mount panelboard cabinets plumb and rigid, without distortion of the box.
 2. Mount recessed panelboards with their fronts uniformly flush with the wall finish, and mating with the back box.
 3. Install floor mounted panelboards on concrete bases.
 4. Attach all panelboards to the vertical finished or structural surface behind the panelboard.
 5. Mount and anchor panelboards in accordance with the requirements specified in Section 16071, Seismic Controls.



6. Unless otherwise indicated in the Contract Documents, mount the top of the trim 90 inches (2286mm) above the finished floor.
 - a. The operating handle of the top-most switch or circuit breaker, when in the in on position, may not be higher than 79 inches (2000mm) above the finished floor or grade.
- C. Temporary Lifting Provisions:
 1. Remove temporary lifting eyes, channels, and brackets, and temporary blocking of moving parts, from the panelboards.
- D. Install overcurrent protective devices and controllers that were not already factory-installed.
- E. Install filler plates in unused spaces.
- F. If ceilings are accessible, or if there are raised floors, or if panelboards are located in spaces that will be finished, provide the following empty conduits:
 1. Stub four 1-inch (27-GRC) empty conduits from each panelboard into accessible ceiling spaces or spaces designated to be ceiling space in the future.
 2. Stub four 1-inch (27-GRC) empty conduits into raised floor spaces or below slabs not on grade.
- G. Arrange the conductors in gutters into groups, and bundle and wrap the conductors with wire ties after completing load balancing.
- H. Special Techniques:
 1. Identification:
 - a. Identify panelboards, field-installed conductors, interconnecting wiring, and components in accordance with the requirements specified in Section 16075, Electrical Identification.
 - 1) Provide warning signs complying with the requirements specified in Section 16075, Electrical Identification.
 - b. Panelboard Schedules:
 - 1) After balancing the panelboard loads, create a directory for each panelboard for installation in the panelboard to indicate the installed circuit loads.
 - a) Use a computer or typewriter to create the directory; handwritten directories are unacceptable.
 - b) Incorporate the Owner's final room designations into the directory.
 - 2) Submit final version of each panelboard schedule to the Program/Project Manager for approval after load balancing has been performed on the panelboard.
 - a) Obtain approval from the Program/Project Manager before installing the directory.



- c. Panelboard Nameplates:
 - 1) Label each panelboard with a nameplate complying with the identification requirements specified in Section 16075, Electrical Identification.
- d. Device Nameplates:
 - 1) Label each branch circuit device in distribution panelboards with a nameplate complying with the identification requirements specified in Section 16075, Electrical Identification.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when panelboards are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) Periodic Special Inspections will be performed during the installation of panelboards.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 - 2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests specified herein, and prepare a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The panelboards included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
 - 3. Insulation Resistance Test:
 - a. Test Procedure:



- 1) For each panelboard bus, component, connecting supply, feeder, and control circuit, have the Testing Agency test the insulation resistance.
 - 2) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the panelboards included and documents the Insulation Resistance Tests, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Panelboard buses, components, connecting supply, feeders, and control circuits having insulation sufficient for the wiring installation to be free from short circuits and from grounds pass the Insulation Resistance Test.
 - a) These items will be considered defective if they do not pass the specified test.
4. Electrical Continuity Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency test the electrical continuity of each circuit.
 - 2) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the panelboards included and documents the Continuity Tests, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Circuits displaying electrical discontinuities fail the Electrical Continuity Test.
5. NETA Acceptance Testing:
 - a. Test Procedure:
 - 1) Have the Testing Agency perform each electrical test specified for panelboards in ANSI/NETA ATS.
 - 2) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the panelboards included and documents the NETA Acceptance Testing, and submit the report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Have the Testing Agency submit certification of compliance with the test parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
6. Infrared Scanning:
 - a. Test Procedure:
 - 1) Instruments and Equipment:
 - a) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - b) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.



- 2) Initial Infrared Scanning:
 - a) After Substantial Completion, but not more than 60 days after Final Acceptance, have the Testing Agency perform an infrared scan of each panelboard.
 - b) Remove the front panels so joints and connections are accessible to the infrared scanner.
- 3) Follow-up Infrared Scanning:
 - a) Have the Testing Agency perform an additional follow-up infrared scan of each panelboard 11 months after the date of Substantial Completion.
- 4) Have the Testing Agency prepare a certified Field Quality-Control Report that identifies the panelboards included and describes the infrared scanning results, and have the Testing Agency submit the report to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Significant deviations from normal temperature values are cause for the panelboard under test to fail the infrared scanning testing.
7. Inspections:
 - a. Have the Testing Agency perform each visual and mechanical inspection specified in ANSI/NETA ATS.
 - 1) Have the Testing Agency submit certification of compliance with the inspection parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
- B. Non-Conforming Work
 1. Panelboards will be considered defective if they do not pass the specified inspections and tests.
 2. Where possible, correct malfunctioning units onsite, and retest the corrected units to demonstrate compliance with the specified requirements; otherwise, replace malfunctioning units with new units and retest the replacement units.
- C. Manufacturer Services:
 1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.05 SYSTEM STARTUP

- A. Prior to starting panelboard equipment or systems, obtain and review the manufacturer's installation, operation, and starting instructions.
 1. Submit the manufacturer's installation, operation, and starting instructions for the panelboard equipment and systems to the Program/Project Manager for information.



- B. Set field-adjustable, circuit-breaker trip ranges as indicated on the Contract Drawings or in the coordination report developed as the Work of Section 16055, Overcurrent Protective Device Coordination.
- C. Verify the correctness of the wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.06 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate them as recommended by manufacturer.
- B. Load Balancing:
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, measure the load balancing, and make circuit changes.
 - 2. Measure the load balancing as directed by the Program/Project Manager during a period of normal system loading.
 - 3. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility, and at a time selected by the Program/Project Manager.
 - a. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 4. After circuit changes have been completed, recheck the loads during a normal load period.
 - a. Record the load readings before and after the changes, and submit test records to the Program/Project Manager for information.
 - 5. Tolerances:
 - a. Within a panelboard, differences exceeding 20 percent between phase loads are unacceptable.
 - 1) Rebalance and recheck phase loads as necessary to comply with these minimum phase load tolerance requirements.

3.07 PROTECTION

- A. Take steps to ensure that installed panelboards are protected during subsequent construction activities.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for panelboards and components for inclusion in emergency manuals and Operation and Maintenance Manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. The overcurrent protective device manufacturer's written instructions for testing and adjusting these devices.



- b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
2. Submit the operation and maintenance data for the panelboards and components to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All.	First edition.





SECTION 16460

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following types of dry-type transformers rated 600 Volts and less, with capacities up to 1000 kVA:
 - a. Distribution transformers.
 - 2. Requirements for a harmonics suppression system (HSS).
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03100 - Concrete Forms and Accessories.
 - 5. Section 03200 - Concrete Reinforcement.
 - 6. Section 03300 - Cast-In-Place Concrete.
 - 7. Section 16061 – Electrical Grounding and Bonding.
 - 8. Section 16070 – Hangers and Supports.
 - 9. Section 16071 – Seismic Controls.
 - 10. Section 16075 – Electrical Identification.
 - 11. Section 16120 – Conductors and Cables.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. dBA: Decibels, referenced to the A-weighting filter curve defined in IEC 61672.
 - 2. HSS: Harmonics suppression system.
 - 3. RMS: Root-mean-square.
 - 4. SCR: Silicon-controlled-rectifier or semiconductor-controlled- rectifier.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.



C. Reference Standards:

1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
 - b. IEEE 519-2014 Recommended Practice for Harmonic Control in Electric Power Systems.
3. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
4. International Electrotechnical Commission (IEC):
 - a. IEC 61672 – Electroacoustics – Sound Level Meters – Part 2: Pattern Evaluation Tests.
5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
6. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA ST 1 - Specialty Transformers (Except General-Purpose Type) [*rescinded*].
 - c. NEMA ST 20 - Dry Type Transformers for General Applications [*rescinded*].
 - d. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers.
 - e. NEMA TP 2 – Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.
8. Underwriters Laboratories, Inc. (UL):
 - a. UL 506 – Standard for Specialty Transformers.
 - b. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.
9. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required



testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

2. Coordinate size and location of concrete bases with the actual transformer provided.
3. Coordinate installation of wall-mounting and structure-hanging supports with the actual transformer provided.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Product Data:
 - 1) Distribution transformers.
 - 2) Based transformers.
 - 3) Transformer nameplates.
- b. Shop Drawings:
 - 1) Transformer equipment assemblies.
- c. Certificates:
 - 1) Seismic Qualification Certificates.
- d. Qualification Statements:
 - 1) Testing Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Test and Evaluation Reports:
 - 1) Recorded transformer secondary voltages and tap settings.
- b. Manufacturer's Instructions:
 - 1) Ventilated-type transformer manufacturer's written instructions for providing temporary heat.
- c. Source Quality Control Submittals:
 - 1) Sound-Level Test Reports.
 - 2) IEEE Standard Test Reports.
 - 3) Harmonic Analysis Reports.
- d. Site Quality Control Submittals:
 - 1) NETA Acceptance Testing Field Quality-Control Reports.
 - 2) Calibration record for the infrared scanning device.
 - 3) Infrared Scanning Field Quality-Control Report.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:



- a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the transformers.
- b. Record Documentation:
 - 1) Output Settings Report.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - 2. Testing and Inspection Agency:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.
- B. Qualifications:
 - 1. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET).
 - 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.
- C. Certifications:
 - 1. Electrical Listing and Labeling:



- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Seismic Qualification Certificates:
 - a. Have the manufacturer prepare Seismic Qualification Certificates certifying that the low-voltage transformers, accessories, and components will withstand the seismic forces defined in Section 16071, Seismic Controls.
 - 1) Indicate whether withstand certification is based on an actual test of the assembled components, or on calculations.
 - 2) Include a dimensioned outline drawing of each equipment unit identifying the center of gravity, and locating and describing the mounting and anchorage provisions.
 - 3) Include a detailed description of the equipment anchorage devices on which the certification is based, and their installation requirements.
 - b. Submit the Seismic Qualification Certificates to the Program/Project Manager for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials and equipment in a clean condition.
 2. Provide equipment needed for unloading operations, and have such equipment on the Site to perform unloading work when the material and equipment is delivered.
 - a. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.
 - b. In the absence of pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.



- c. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by the manufacturers.
 3. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Handle materials and equipment in accordance with the manufacturer's written instructions.
2. Store all products whether onsite or off-site, indoors on blocking or pallets.
3. Follow the manufacturer's written instructions for storing the items.
4. Store the electrical equipment and products under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

C. Packaging Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Temporary Heating:
 - a. Throughout periods during which ventilated-type equipment is not energized, and when these transformers are not in a continuously controlled space that is under normal temperature and humidity conditions, provide temporary heat within the enclosure of each ventilated-type unit in accordance with the manufacturer's written instructions.
 - b. Submit the ventilated-type transformer manufacturer's written instructions for providing temporary heat to the Program/Project Manager for information.

PART 2 PRODUCTS

2.01 LOW-VOLTAGE TRANSFORMER EQUIPMENT

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - b. Source Limitations:



- 1) Obtain each transformer type from a single source from a single manufacturer.

B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

b. National Electrical Code (NEC):

- 1) Provide products and installation complying with requirements specified for transformers in NFPA 70.

C. Performance:

1. Seismic Performance:

- a. Provide transformers capable of withstanding the effects of earthquake motions as defined in Section 16071, Seismic Controls.
 - 1) The phrase "capable of withstanding" is hereby defined to mean the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

2. Harmonics Suppression System (HSS) Performance:

- a. Provide Harmonic Study in accordance with IEEE 519.
- b. Verify system resonance in accordance with IEEE 399, Section 10.4.3.
- c. Compare maximum harmonic distortion limits at the service entrance section and motor control center under normal load operating conditions.
- d. Compare to maximum distortion limits per IEEE 519, Section 5.
- e. Analyze system against acceptable levels, TDD vs THD.
- f. Harmonic measurement instruments shall comply with IEC 61000 4-7 and IEC 61000-4-30.
- g. Provide analysis results and report in summary table for approval.

D. Design Criteria:

1. Transformers:

- a. Provide factory-assembled and factory-tested, air-cooled transformer units designed for 60 Hertz service, and having a 3-phase, 3-wire primary, and a 3-phase, 4-wire secondary.
 - 1) Cores:



- a) Provide grain-oriented, non-aging silicon steel transformer cores.
 - 2) Coils:
 - a) Provide continuous copper coil windings without splices except for taps.
 - b) Provide brazed or pressure type internal coil connections.
 - b. Provide transformer units complying with the requirements specified in IEEE C57.12.91.
 - 2. Harmonics Suppression System (HSS):
 - a. Provide transformers having integral low frequency harmonic suppression obtained via a passive device installed at the secondary of a wye-connected distribution transformer having voltage of 120/208 and a frequency of 60 Hertz as required by the Harmonic Analysis Report.
 - 3. Product Data:
 - a. Submit Product Data for each type and size of transformer to be provided under this Section to the Program/Project Manager for approval.
 - 1) Include the rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
 - 4. Shop Drawings:
 - a. Submit Shop Drawings that detail the transformer equipment assemblies, and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and the location and size of each field connection to the Program/Project Manager for approval.
 - 1) Wiring Diagrams:
 - a) Include power, signal, and control wiring diagrams.
- E. Materials:
- 1. Distribution Transformers:
 - a. Provide distribution transformers complying with the requirements specified in NEMA ST 20, and listed and labeled in accordance with the requirements specified in UL 1561.
 - b. Provide transformers that are constructed to withstand the seismic forces specified in Section 16071, Seismic Controls.
 - c. Cores:
 - 1) Provide transformer cores having 1 leg per phase.
 - d. Low-Sound-Level Requirements:
 - 1) Provide a minimum low-sound-level of 3 dBA less than the standard sound levels specified in NEMA ST 20 when factory-tested in accordance with the methods specified in IEEE C57.12.91.
 - e. Enclosure:



- 1) Provide totally enclosed, nonventilated transformer enclosures complying with the requirements for NEMA Type 2 enclosures specified in NEMA 250.
- 2) Provide cores and coils encapsulated within a resin compound that, seals out both moisture and air.
- f. Transformer Enclosure Finish:
 - 1) Provide a gray transformer enclosure finish complying with the requirements specified in NEMA 250.
- g. Taps:
 - 1) For transformers rated smaller than 3 kVA, provide one 5 percent tap above the normal full capacity.
 - 2) For transformers rated 7.5 kVA to 24 kVA, provide one 5 percent tap above and one 5 percent tap below normal full capacity.
 - 3) For transformers rated 25 kVA and larger, provide two 2.5 percent taps above and two 2.5 percent taps below the normal full capacity.
- h. Insulation Class:
 - 1) Provide a UL-component-recognized insulation system rated for 220 degrees Celsius, with a maximum of 80 degrees Celsius rise above a 40 degrees Celsius ambient temperature.
- i. Energy Efficiency:
 - 1) For transformers rated 15 kVA and larger, provide units complying with the requirements for Class 1 efficiency levels specified in NEMA TP 1 when tested in accordance with the methods specified in NEMA TP 2.
- j. Wall Brackets:
 - 1) For transformers indicated to be wall-mounted on the Contract Drawings, provide the manufacturer's standard wall brackets.
- k. Fungus Proofing:
 - 1) Provide permanent fungicidal treatment for the transformer coils and cores.
- l. Manufacturers:
 - 1) ACME Electric Corporation, Power Distribution Products Division, <https://www.hubbell.com/acmeelectric/en/>.
 - 2) Controlled Power Company, www.controlledpwr.com.
 - 3) Cutler-Hammer, Eaton Electrical Inc., www.eaton.com/EatonCom/Markets/Electrical/.
 - 4) Federal Pacific Transformer Company, Division of Electro-Mechanical Corp., www.federalpacific.com
 - 5) Hammond Manufacturing Ltd., www.hammondmfg.com.
 - 6) Magnetek, www.magnetek.com.
 - 7) Micron Industries Corp., www.microntransformers.com.
 - 8) Myers Power Products, Inc., <http://www.myerspwrproducts.com>.
 - 9) Sola/Hevi-Duty, <http://www.solahevidutysales.com/>.



- 10) Square D; a brand of Schneider Electric, www.schneider-electric.us.
- 11) Approved equal.
2. Harmonics Suppression System (HSS):
 - a. Provide a harmonics suppression system (HSS) that has the specified performance as identified in the Harmonic Analysis Report.

2.02 ACCESSORIES

- A. Identification Devices:
 1. Transformer Nameplates:
 - a. For each transformer, provide laminated-plastic or metal engraved nameplates as specified in Section 16075, Electrical Identification, and mounted with corrosion-resistant screws.

2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein, or as required by the Program/Project Manager.
 2. Sound-Level Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency factory-test the sound-level of the equipment provided for this Contract under this Section in accordance with the methods specified in IEEE C57.12.91.
 - 2) Have the Testing Agency prepare source quality-control Sound-Level Test Reports documenting the results of the testing, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Equipment having a minimum low-sound-level of 3 dBA less than the standard sound levels specified in NEMA ST 20 passes the Sound-Level Test.
 3. IEEE Standard Tests:
 - a. Test Procedure:
 - 1) Have the Testing Agency factory-test the transformers in accordance with the requirements specified in IEEE C57.12.91.
 - 2) Have the Testing Agency prepare source quality-control IEEE Standard Test Reports documenting the results of the testing, and submit them to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Equipment complying with the requirements specified in IEEE C57.12.91 passes the IEEE Standard Tests
 4. Inspections:
 - a. Have the Testing Agency inspect the transformers in accordance with the requirements specified in IEEE C57.12.91.



- B. Non-Conforming Work:
 - 1. Do not allow defective equipment to be shipped to the Site.
- C. Coordination of Other Tests and Inspections:
 - 1. Notify the code-required Approved Agency responsible for performing special inspections when transformers for this Contract are being fabricated and/or tested.
 - 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine conditions where the transformers will be installed for compliance with the enclosure- temperature and ambient-temperature requirements for each transformer.
 - 2. Verify by field measurements that the dimensions are as needed to maintain the working clearances required by NFPA 70 and manufacturer's written instructions.
 - 3. Examine walls, floors, roofs, and concrete bases where the transformers will be installed for suitable mounting conditions.
 - 4. Verify that the ground connections are in place, and that the requirements specified in Section 16061, Electrical Grounding and Bonding, have been met.
 - a. The maximum allowable ground resistance at the location of a transformer is 5 ohms.
- B. Evaluation and Assessment:
 - 1. Proceed to install the transformers only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the transformers.
- B. Surface Preparation:
 - 1. For floor mounted transformers, provide concrete bases having a minimum 4-inch (100mm) nominal thickness constructed according to the manufacturer's written instructions, the seismic codes applicable to the Contract, and the requirements specified in Section 16070, Hangers and Supports.
 - a. Cast anchor-bolt inserts into the concrete bases.



- 1) Install anchor bolts to the elevations required for proper attachment to the transformers.
- b. Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.

3.03 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by the transformer manufacturer.
 1. Brace wall-mounted transformers as specified in the seismic codes applicable to the Contract and Section 16071, Seismic Controls.
- B. Install and anchor floor-mounted transformers level and plumb on concrete bases.
- C. Systems Integration:
 1. Ground the transformer equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 2. Connect the transformer wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. During the period when the transformers are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
 2. Testing Agency Responsibilities:
 - 1) Have the Testing Agency employed by the Contractor perform the tests and inspections specified herein, and prepare a written Field



Quality-Control Report for each test and inspection conducted to record the following information pertaining to the test or inspection:

- a) The transformers included in the testing.
- b) Test procedures used to perform the testing.
- c) Test results that comply with the requirements specified.
- d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, remedial action taken, and observations after remedial action.

3. NETA Acceptance Testing:

a. Test Procedure:

- 1) Have the Testing Agency perform each electrical test specified for transformers in ANSI/NETA ATS.
- 2) Have the Testing Agency prepare a certified NETA Acceptance Testing Field Quality-Control Report that identifies the transformers included and documents the NETA acceptance testing, and submit the Report to the Program/Project Manager for information.

b. Acceptance Criteria:

- 1) Have the Testing Agency submit certification of compliance with the test parameters specified in ANSI/NETA ATS to the Program/Project Manager for approval.
- 2) Test Labeling:
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.

4. Infrared Scanning:

a. Test Procedure:

- 1) Instruments and Equipment:
 - a) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
 - b) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
- 2) Initial Infrared Scanning:
 - a) Two months after Substantial Completion, have the Testing Agency perform an infrared scan of the transformer connections.
- 3) Follow-up Infrared Scanning:
 - a) Have the Testing Agency perform 2 additional follow-up infrared scans of each transformer, the first follow-up scan 4 months after the date of Substantial Completion, and the second follow-up scan 7 months after the first follow-up scan.



- 4) Have the Testing Agency prepare a certified Infrared Scanning Field Quality-Control Report that identifies the transformers included and describes the infrared scanning results, and submit the report to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Significant deviations from normal temperature values are cause for the transformer under test to fail the infrared scanning testing.
 - 2) Test Labeling:
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
5. Inspections:
 - a. Have the Testing Agency perform each visual and mechanical inspection and electrical test specified in ANSI/NETA ATS.
- B. Non-Conforming Work
 1. Remove and replace units that do not pass the tests or inspections, and retest the replacements as specified above.
- C. Manufacturer Services:
 1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - a. Have the factory-authorized service representative perform tests and inspections, and prepare and submit certified test reports to the Program/Project Manager for information.

3.05 ADJUSTING

- A. Record the transformer secondary voltage at each low-voltage transformer unit for at least 48 hours of a typical occupancy period.
 1. Adjust the transformer taps to provide the optimum voltage conditions at the secondary terminals.
 - a. Optimum is defined as not exceeding the nameplate voltage plus 10 percent, and not being lower than the nameplate voltage minus 3 percent, at maximum load conditions.
 2. Submit the recorded transformer secondary voltages and tap settings as test results to the Program/Project Manager for information.
- B. Output Settings Report:
 1. Prepare a written Output Settings Report recording the output voltages and tap settings, and submit the Report to the Program/Project Manager for information.



3.06 CLEANING

- A. Clean the area around the transformers by vacuuming dirt and debris; do not use compressed air to assist in the cleaning.
- B. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Take steps to ensure that installed transformers are protected during subsequent construction activities.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for the transformers for inclusion in emergency and Operation and Maintenance manuals as specified in Section 01780, Closeout Submittals.
 - 2. Submit the operation and maintenance data for the transformers to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16491

FUSES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for cartridge fuses rated 600 Volts AC and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
 - 2. Requirements for plug fuses rated 125 Volts AC and less for use in plug-fuse-type enclosed switches, fuseholders, and panelboards.
 - 3. Requirements for plug-fuse adapters for use in Edison-base, plug-fuse sockets.
 - 4. Requirements for spare-fuse cabinets.
- B. Products Supplied But Not Installed Under This Section:
 - 1. Generally, the fuses supplied under this Section are installed in equipment provided under other Sections as part of that equipment's startup activities.
- C. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16055 – Overcurrent Protective Device Coordination.
 - 4. Section 16075 – Electrical Identification.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating current.
- B. Definitions:
 - 1. Fuse: A type of electrical overcurrent protective device that typically has a conductive element that melts when too much current flows which in turn interrupts the connected circuit.
- C. Reference Standards:
 - 1. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - 2. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
 - 3. National Fire Protection Association (NFPA).
 - a. NFPA 70 – National Electrical Code (NEC).



4. National Electrical Manufacturers Association (NEMA):
 - a. NEMA FU 1 - Low Voltage Cartridge Fuses.
5. Underwriters Laboratories, Inc. (UL):
 - a. UL 248-11 - Low-Voltage Fuses - Part 11: Plug Fuses.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate the selection of fuses for electrical equipment with the required average melt characteristics and peak let-through currents indicated in the studies prepared as specified in Section 16055, Overcurrent Protective Device Coordination.
- B. Sequencing:
 1. Take responsibility for arranging the Work and issuing purchase orders to facilitate securing delivery of the fuses and related items, so the Work progresses without delay or interruption.

1.04 SUBMITTALS

- A. Action Submittals:
 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Cartridge fuses.
 - 2) Plug fuses.
 - 3) Plug-fuse adapters.
 - 4) Spare-fuse cabinets.
 - b. Certificates:
 - 1) Electrical component, device, and accessory certification.
- B. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Fuses.
- C. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish extra fuses matching the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.



- a) For each size and type of fuse, provide fuses equal in number to 10 percent of the quantity installed, but no fewer than 2 of each size and type.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:

- a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

B. Certifications:

1. Electrical Component, Device, and Accessory Certifications:

- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.

B. Storage and Handling Requirements:

1. Protect fuse products from dirt and corrosion by placing them in closed containers.
 - a. Store fastener products in a protected shelter



1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Evaluate the ambient temperatures to determine if fuse rating adjustment factors must be applied to the fuse ratings.
 - a. Where the ambient temperature to which fuses are directly exposed is less than 40 degrees Fahrenheit (5 degrees Centigrade) or more than 100 degrees Fahrenheit (38 degrees Centigrade), apply the manufacturer's ambient temperature adjustment factors to the fuse ratings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers:

1. Manufacturer List:
 - a. Cooper Bussmann, Inc., www.cooperbussmann.com.
 - b. Automation Direct, <https://www.automationdirect.com/>.
 - c. Merson Electric Power, <http://ep-us.mersen.com/>.
 - d. Littelfuse, Inc., www.littelfuse.com.
 - e. Approved equal.
2. Substitution Limitations:
 - a. Source Limitations:
 - 1) Obtain fuses for use within a specific product or circuit from a single source from a single manufacturer.

B. Description:

1. Regulatory Requirements:
 - a. National Electrical Code (NEC):
 - 1) Comply with requirements specified for fuses in NFPA 70.

C. Performance:

1. Cartridge Fuses:
 - a. For cartridge fuse applications, comply with the requirements specified in NEMA FU 1.
 - b. Service Entrances:
 - 1) For service entrances, provide Class RK1, time delay cartridge fuses.
 - c. Feeders:
 - 1) For feeders, provide Class RK1, time delay cartridge fuses.
 - d. Motor Branch Circuits:
 - 1) For motor branch circuits, provide Class RK1, time delay cartridge fuses.
 - e. Other than Motor Branch Circuits:



- 1) For other than motor branch circuits, provide Class RK1, time delay cartridge fuses.
 - f. Control Circuits:
 - 1) For control circuits, provide Class CC, time delay cartridge fuses.
 2. Plug Fuses:
 - a. For plug fuse applications, comply with the requirements specified in UL 248-11.
- D. Design Criteria:
1. Fuse Applications:
 - a. Select fuse classes and types by coordinating the required average melt characteristics and peak let-through currents with the studies prepared as specified in Section 16055, Overcurrent Protective Device Coordination.
 2. Product Data:
 - a. For each product specified under this Section, submit Product Data to the Program/Project Manager for approval.
 - 1) Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets.
 - 2) Include the following information for each fuse type indicated:
 - a) Ambient Temperature Adjustment Information:
 - (1) If the ratings of the uses have been adjusted to accommodate ambient temperatures, provide a list of the fuses with adjusted ratings.
 - (2) For each fuse having adjusted ratings, include the location of the fuse, the original fuse rating, the local ambient temperature, and the adjusted fuse rating.
 - (3) Furnish the manufacturer's technical data on which the ambient temperature adjustment calculations are based.
 - b) Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - c) Current-limitation curves for fuses with current-limiting characteristics.
 - d) Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - e) Coordination charts and tables and related data.
 - f) Fuse sizes for elevator feeders and elevator disconnect switches.
- E. Materials:
1. Cartridge Fuses:
 - a. Provide nonrenewable cartridge fuses having voltage ratings consistent with the circuit voltages, and complying with the requirements specified in NEMA FU 1.
 2. Plug Fuses:



- a. Provide nonrenewable plug fuses having a 125 Volt AC rating, and complying with the requirements specified in UL 248-11.
3. Plug-Fuse Adapters:
 - a. Provide plug-fuse adapters capable of retrofitting Edison-base fuseholders or sockets with Type S, rejection-base plug fuses.
 - 1) Provide plug-fuse adapters that are irremovable once installed.
 - b. Provide plug-fuse adapters having ampere ratings matching the fuse ratings.

2.02 ACCESSORIES

- A. Spare-Fuse Cabinets:
 1. Provide wall-mounted steel spare-fuse cabinet units having a full-length, recessed piano-hinged door and a key-coded cam lock and pull.
 - a. Size:
 - 1) Provide spare-fuse cabinet units adequately sized to store the spare fuses specified; and, in addition, a minimum 15 percent spare capacity.
 - b. Finish:
 - 1) Provide spare-fuse cabinet units having a gray, baked enamel finish.
 - c. Identification:
 - 1) Apply a 1-1/2 inch (38mm) high lettered label reading "SPARE FUSES" to the exterior of the cabinet door.
 - d. Fuse Pullers:
 - 1) Where applicable and available, provide fuse pullers for each size of fuse from fuse manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- B. Evaluation and Assessment:
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Examine utilization equipment nameplates and installation instructions.
 1. Coordinate the fuse ratings with the utilization equipment nameplate limitations of the maximum fuse size, and with system short-circuit current levels.



- B. Install plug-fuse adapters in Edison-base fuseholders and sockets if required.
 - 1. Ensure that the adapters are irremovable once they have been installed.
- C. Install the fuses in fusible devices.
 - 1. Examine fuses before installation.
 - a. Reject fuses that are moisture damaged or physically damaged.
 - 2. Install fuses of the sizes and with the characteristics appropriate for each piece of equipment.
 - 3. Arrange the installed fuses so their rating information is readable without having to remove the fuses.
- D. Provide identification labels in accordance with the requirements specified in Section 16075, Electrical Identification; and indicate fuse replacement information on the inside door of each fused switch and adjacent to each fuse block, socket, and holder.
- E. Install spare-fuse cabinets in accordance with the cabinet manufacturer's recommendations.
 - 1. Submit the manufacturer's recommendations for installing the spare-fuse cabinets to the Program/Project Manager for information.

3.03 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for fuses to be included in emergency, operation, and maintenance manuals.
 - a. In addition to items specified in Section 01780, Closeout Submittals, include the following:
 - 1) Ambient temperature adjustment information.
 - 2) Current-limitation curves for fuses with current-limiting characteristics.
 - 3) Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - a) Submit the curves on translucent log-log graph paper.
 - 4) Coordination charts and tables, and related data.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16497

AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for automatic transfer switches rated 600 Volts and less.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 03100 - Concrete Forms and Accessories.
 - 7. Section 03200 - Concrete Reinforcement.
 - 8. Section 03300 - Cast-In-Place Concrete.
 - 9. Section 16061 - Electrical Grounding and Bonding.
 - 10. Section 16070 - Hangers and Supports.
 - 11. Section 16075 - Electrical Identification.
 - 12. Section 16120 - Conductors and Cables.
 - 13. Section 16234 - Diesel Electric Generators.
 - 14. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
- B. Definitions:
 - 1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
 - 2. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
- C. Reference Standards:
 - 1. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):



- a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C62.41 – IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - b. ANSI/NETA ETT - Standard for Certification of Electrical Testing Technicians.
6. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
 - c. NEMA ICS 1 - Industrial Control and Systems: General Requirements.
 - d. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
7. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
 - b. NFPA 99 – Health Care Facilities Code.
 - c. NFPA 110 - Standard for Emergency and Standby Power Systems.
8. National Institute for Certification in Engineering Technologies (NICET), www.nicet.org:
 - a. Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.
9. Underwriters Laboratories, Inc. (UL):
 - a. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - b. UL 508 - Standard for Industrial Control Equipment.
 - c. UL 869A – Reference Standard for Service Equipment.
 - d. UL 1008 - Standard for Transfer Switch Equipment.
10. United States Government:
 - a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required



testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

2. Coordinate the size and location of concrete bases for the automatic transfer switches.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Automatic transfer switches.
 - b. Shop Drawings:
 - 1) Automatic transfer switches.
 - 2) Single-line diagram.
 - c. Qualification Statements:
 - 1) Diesel electric generator manufacturer's qualifications.
 - 2) Testing Agency's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Automatic transfer switch manufacturer's written installation instructions.
 - b. Site Quality Control Submittals:
 - 1) Field Quality-Control Report for the Insulation Resistance Test.
 - 2) Field Quality-Control Report for the Ground-Fault Tests.
 - 3) Field Quality-Control Report for the Performance Test.
 - 4) Field Quality-Control Report for the NETA Acceptance Testing.
 - 5) Field Quality-Control Report for the Infrared Scanning.
 - 6) Calibration record for the infrared scanning device.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the automatic transfer switches and accessories.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:



1. Special Inspections:
 - a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
 - b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
 - c. Periodic Special Inspections will be performed during the installation of automatic transfer switches and accessories.
2. Testing and Inspection Agencies:
 - a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Automatic Transfer Switch Manufacturer's Qualifications:
 - a. Procure products from a qualified manufacturer.
 - b. Procure products from a manufacturer that maintains a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
 - c. Submit the automatic transfer switch manufacturer's qualifications to the Program/Project Manager for approval.
2. Testing Agency's Qualifications:
 - a. Employ an independent Testing Agency that is a member company of the InterNational Electrical Testing Association, or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, that is acceptable to the Authorities Having Jurisdiction (AHJ), and that has the experience and capability to conduct the testing specified herein.
 - 1) Testing Agency's Field Supervisor:
 - a) The Testing Agency's field supervisor to supervise onsite field quality control testing must be currently certified by the InterNational Electrical Testing Association (NETA) in accordance with the requirements specified in ANSI/NETA ETT, or by the National Institute for Certification in Engineering Technologies (NICET) in accordance with the requirements specified in the Industrial Instrumentation Engineering Technology Industrial Instrumentation Program Detail Manual.



- 2) Submit the qualifications of the Testing Agency, including the Testing Agency field supervisor's qualifications, to the Program/Project Manager for approval.

C. Certifications:

1. Electrical Listing and Labeling:

- a. Provide electrical components, devices, and accessories that are listed and labeled for the location the product is installed in, and the application intended, by a Nationally Recognized Testing Laboratory (NRTL), as defined in Article 100 of NFPA 70, acceptable to the Authorities Having Jurisdiction (AHJ), unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
- b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Package and protect materials to limit field repairs.
 - a. Deliver pre-finished products in a manner that will prevent material damage and deterioration or contamination from the elements.

B. Storage and Handling Requirements:

1. Store and handle products in a manner that will prevent material damage and deterioration or contamination from the elements.

C. Packaging Waste Management:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. Remove loose packing and flammable materials from inside the automatic transfer switches.
3. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.



1.07 SITE CONDITIONS

A. Existing Conditions:

1. Interruption of Existing Electric Service:

- a. Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electric service according to the requirements indicated:
 - 1) Notify the Program/Project Manager no fewer than 2 weeks in advance of the proposed interruption of electric service.
 - 2) Do not interrupt electric service without the Program/Project Manager's written permission.

PART 2 PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH ASSEMBLIES

A. Manufacturers:

1. Manufacturer List:

- a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 1) Eaton Electrical Inc.; Cutler-Hammer, www.eaton.com.
 - 2) GE Zenith Controls, www.geindustrial.com.
 - 3) Generac Power Systems, Inc., <http://www.generac.com>.
 - 4) Approved equal.

2. Substitution Limitations:

- a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
- b. Source Limitations:
 - 1) Obtain the automatic transfer switches from a single source and single manufacturer.

B. Description:

1. Regulatory Requirements:

- a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].
- b. National Electrical Code (NEC):
 - 1) Provide products and installation complying with the requirements specified for automatic transfer switches in NFPA 70.

C. Performance:

1. Indicated Current Ratings:



- a. Unless otherwise indicated in the Contract Documents, the indicated current ratings apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of the switch ampere rating.
 - 2. Tested Fault-Current Closing and Withstand Ratings:
 - a. Provide automatic transfer switches having tested fault-current closing and withstand ratings based on testing in accordance with the requirements specified in UL 1008 that are adequate for the duty imposed by the protective devices at the installed locations under the fault conditions indicated in the Contract Documents.
 - 1) Where the transfer switch includes internal fault-current protection, provide automatic transfer switches having a rating of the switch and trip unit combination exceeding the indicated fault-current value at the installation location.
 - 3. Solid-State Controls:
 - a. Provide automatic transfer switches with solid-state controls having a repetitive accuracy of all settings of plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 degrees Celsius.
 - 4. Resistance to Damage by Voltage Transients:
 - a. Provide automatic transfer switches having components capable of meeting or exceeding the voltage-surge withstand capability requirements when tested in accordance with the method specified in IEEE C62.41, and components capable of meeting or exceeding the voltage-impulse withstand test requirements when tested in accordance with the method specified in NEMA ICS 1.
- D. Design Criteria:
- 1. Provide automatic transfer switches complying with the design and installation requirements specified in NEMA ICS 1, NFPA 99, and NFPA 110.
 - 2. Except where the requirements specified in this Section are stricter, provide automatic transfer switches complying with the design and installation requirements specified in UL 1008.
 - 3. Transfer Switches Based on Molded-Case-Switch Components:
 - a. Provide automatic transfer switches based on molded-case-switch components complying with the requirements specified in NEMA AB 1, UL 489, and UL 869A.
 - 4. Automatic Open-Transition Transfer Switches:
 - a. Provide automatic open-transition transfer switches having the following functions and characteristics:
 - 1) Fully automatic break-before-make operation.
 - 2) Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 milliseconds.
 - 3) Initiation of No-Interruption Transfer:



- a) The initiation of no-interruption Transfer is controlled by the in-phase monitor and sensors confirming both sources are present and acceptable.
 - b) Initiation occurs without active control of generator.
 - 4) Failure of the power source serving the load initiates an automatic break-before-make transfer.
- 5. Switch Characteristics:
 - a. Provide automatic transfer switches designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1) Switch Action:
 - a) Provide automatic transfer switches having a double throw switch action, mechanically held in both directions.
 - 2) Contacts:
 - a) Provide automatic transfer switches having silver composition or silver alloy contacts for load-current switching.
 - (1) For conventional automatic transfer-switch units, rated for 225 Amperes and higher, provide separate arcing contacts.
 - b. Switching Arrangement:
 - 1) Unless otherwise indicated in the Contract Documents, provide automatic transfer switches having a double-throw type switching arrangement that is incapable of pauses or intermediate position stops during normal functioning.
 - c. Neutral Switching.
 - 1) For four-pole switches, provide automatic transfer switches that switch the neutral pole simultaneously with the phase poles.
- 6. Oversize Neutral:
 - a. For automatic transfer switches having an oversize neutral, provide a neutral path through the units having double the ampacity and switch ratings of the nominal rating of the circuit in which the switch is installed.
- 7. Fasteners and Supports:
 - a. Design each fastener and support to carry the load.
- 8. Product Data:
 - a. Obtain the manufacturer's Product Data for each type of automatic transfer switch specified.
 - 1) Include the automatic transfer switch's rated capacities, operating characteristics, and furnished specialties and accessories.
 - b. Submit the Product Data to the Program/Project Manager for approval.
- 9. Shop Drawings:
 - a. Prepare Shop Drawings for the automatic transfer switches that include dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space,



installed features and devices, and material lists for each switch specified.

- 1) Furnish dimensioned outline drawings of the automatic transfer switch unit that identify the center of gravity, and that locate and describe mounting and anchorage provisions.
- b. Single-Line Diagram:
 - 1) Furnish single-line diagram showing the connections between the transfer switch, bypass/isolation switch, power sources, and load; and that show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- c. Submit the Shop Drawings and single-line diagram to the Program/Project Manager for approval.

E. Operation:

1. Electrical Operation:
 - a. Provide automatic transfer switches capable of being electrically operated by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
2. Manual Switch Operation:
 - a. Provide automatic transfer switches capable of manual switch operation under load, with either or both sources energized.
 - 1) The transfer time under manual switch operation must be the same as for electrical operation.
 - b. Provide automatic transfer switches that automatically disconnect the control circuit from the electrical operator during manual operation.

F. Materials:

1. Automatic Transfer Switches:
 - a. Provide automatic transfer switches complying with the requirements for Level 1 equipment specified in NFPA 110.
 - b. Enclosures:
 - 1) Unless otherwise indicated in the Contract Documents, provide general-purpose enclosures complying with the requirements for NEMA Type 1 enclosures specified in NEMA 250, and complying with the requirements specified in NEMA ICS 6 and UL 508.
 - c. Signal-Before-Transfer Contacts:
 - 1) Provide automatic transfer switches having a set of normally open/normally closed dry contacts that operate in advance of a retransfer to the normal source.
 - 2) Provide automatic transfer switches capable of adjustment of the signal-before-transfer interval from 1 to 30 seconds.
 - d. Digital Communication Interface:
 - 1) Provide automatic transfer switches having a digital communication interface matched to the capability of the remote annunciator or annunciator and control panel.



- e. Undervoltage Sensing for Each Phase of Normal Source:
 - 1) Provide automatic transfer switches capable of sensing low phase-to-ground voltage on each phase.
 - a) Provide automatic transfer switches capable of allowing the pickup voltage to be adjusted from 85 percent to 100 percent of the nominal, and of allowing the dropout voltage to be adjusted from 75 percent to 98 percent of pickup value.
 - b) Factory set the automatic transfer switches for pickup at 90 percent and dropout at 85 percent.
- f. Adjustable Time Delay:
 - 1) To override the normal-source voltage sensing so the transfer and engine start signals can be delayed, provide automatic transfer switches having a time delay adjustable from 0 to 6 seconds, and factory-set the time delay for 1 second.
- g. Voltage/Frequency Lockout Relay:
 - 1) Provide automatic transfer switches having a voltage/frequency lockout relay that prevents premature transfer to the generator.
 - a) Provide automatic transfer switches having a voltage/frequency lockout relay that is adjustable from 85 percent to 100 percent of nominal voltage.
 - (1) Factory set the voltage/frequency lockout relay for pickup voltage at 90 percent.
 - b) Provide automatic transfer switches having a voltage/frequency lockout relay having a pickup frequency adjustable from 90 percent to 100 percent of nominal.
 - (1) Factory set the voltage/frequency lockout relay pickup frequency for pickup at 95 percent.
- h. Time Delay for Retransfer to Normal Source:
 - 1) Provide automatic transfer switches having a time delay for retransfer to normal source that is adjustable from 0 to 30 minutes.
 - 2) Factory set the time delay for 10 minutes to automatically defeat a delay on loss of voltage or sustained undervoltage of the emergency source, provided that the normal supply has been restored.
- i. Test Switch:
 - 1) Provide automatic transfer switches having a test switch that simulates normal-source failure.
- j. Switch-Position Pilot Lights:
 - 1) Provide automatic transfer switches having switch-position pilot lights that indicate the source to which the load is connected.
- k. Source-Available Indicating Lights:
 - 1) Provide automatic transfer switches having source-available indicating lights that supervise the sources via transfer-switch normal-source and emergency-source sensing circuits.



- a) Normal Power Supervision:
 - (1) Provide green normal power supervision indicating lights having a nameplate engraved "Normal Source Available."
- b) Emergency Power Supervision:
 - (1) Provide red emergency power supervision indicating lights having a nameplate engraved "Emergency Source Available."
- l. Unassigned Auxiliary Contacts:
 - 1) Provide automatic transfer switches having 2 normally open, single-pole, double-throw contacts for each switch position, rated at 10 Amperes at 240 Volts AC.
- m. Transfer Override Switch:
 - 1) Provide automatic transfer switches having a transfer override switch that overrides the automatic retransfer control so the automatic transfer switch will remain connected to the emergency power source regardless of the condition of the normal source.
 - 2) Provide a pilot light that indicates the override status.
- n. Engine Shutdown Contacts:
 - 1) Provide automatic transfer switches having engine shutdown contacts that initiate shutdown at remote engine-generator controls after retransfer of the load to normal source, and that have a time delay adjustable from 0 to 5 minutes.
 - a) Factory set the engine shutdown contact time delay for 5 minutes.
- o. Engine-Generator Exerciser:
 - 1) Provide automatic transfer switches having a solid-state, programmable time switch that starts the engine generator and transfers the load to it from the normal source for a preset time, then retransfers and shuts down the engine after a preset cool-down period.
 - a) Provide a time switch that initiates the exercise cycle at preset intervals adjustable from 7 days to 30 days.
 - (1) Provide a time switch that allows running periods to be adjusted from 10 minutes to 30 minutes.
 - (2) Factory-set the engine-generator exerciser for a 7-day exercise cycle, a 20-minute running period, and a 5-minute cool-down period.
 - b) Provide an engine-generator exerciser that includes the following features:
 - (1) Exerciser Transfer Selector Switch:
 - (a) Provide an engine-generator exerciser having an exerciser transfer selector switch that permits selection of the exercise with or without load transfer.
 - (2) Provide an engine-generator exerciser having push-button programming control with a digital display of the settings.

- (3) Provide an engine-generator exerciser capable of allowing operation of the time switch on integral battery power when normal control power is unavailable.
- p. Factory Wiring:
 - 1) Factory-wire the automatic transfer switches so their wiring is trained, bundled, and labeled consistently with the designations on the Shop Drawings; either by color-coding the wiring or by attaching numbered or lettered wire and cable tape markers at the terminations.
 - a) Color-coding and wire and cable tape markers are specified in Section 16075, Electrical Identification.
 - 2) Designated Terminals:
 - a) Designate the automatic transfer switch terminals using pressure type designators, suitable for the types and sizes of field wiring indicated in the Contract Documents.
 - 3) Power-Terminal Arrangement and Field-Wiring Space:
 - a) Provide automatic transfer switches having a power-terminal arrangement and field-wiring space suitable to allow top, side, or bottom entrance of the feeder conductors as indicated in the Contract Documents.
 - 4) Control Wiring:
 - a) Provide automatic transfer switches equipped with lugs suitable for connecting the control wiring to terminal strips.
2. Annunciation, Control, and Programming Interface Components:
 - a. Provide annunciation, control, and programming interface devices at the automatic transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels, and having their communication capability matched with that of the remote device.

2.02 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
1. Materials specified in this Section require advance examination or testing in accordance with the methods specified herein, or as required by the Program/Project Manager.
 - a. Before the tests will be performed, provide advance notice of the tests to the Program/Project Manager to give the Program/Project Manager and the Approved Agency the opportunity to observe the tests.
 2. Factory Test:
 - a. Factory-test and inspect the automatic transfer switch components, assembled switches, and associated equipment.
 - b. Test Procedure:
 - 1) Check the transfer time and voltage, frequency, and time-delay settings for compliance with the specified requirements.



- 2) Perform the dielectric strength test in accordance with the method specified in NEMA ICS 1.
- c. Acceptance Criteria:
 - 1) Ensure proper operation of the automatic transfer switch components, assembled switches, and associated equipment.
- B. Coordination of Other Tests and Inspections:
 1. Notify the code-required Approved Agency responsible for performing special inspections when automatic transfer switches for this Contract are being fabricated and/or tested.
 2. Cooperate with the code-required Approved Agency when they are performing required material verifications and other special inspections.
 - a. Provide full access to the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. With the automatic transfer switch installer present, examine the areas, equipment bases, and conditions where the automatic transfer switches will be installed for compliance with the requirements for installation and other conditions affecting the automatic transfer switch performance.
- B. Pre-Installation Testing:
 1. Proceed installing the automatic transfer switches only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the automatic transfer switches.
- B. Surface Preparation:
 1. Concrete Bases:
 - a. Provide flat concrete pads to support the automatic transfer switches.
 - 1) Provide 4-inch high reinforced concrete bases with chamfered edges to support the automatic transfer switches.
 - 2) Extend the base no more than 4 inches (100mm) in all directions beyond the maximum dimensions of the automatic transfer switches, unless otherwise indicated on the Contract Drawings.
 - b. Construct the concrete bases in accordance with Section 03200, Concrete Reinforcement.
 - 1) Provide concrete formwork as specified in Section 03100, Concrete Forms and Accessories; concrete reinforcement as specified in Section 03200, Concrete Reinforcement; and



concreting as specified in Section 03300, Cast-In-Place Concrete, that comply with the requirements for concrete bases.

- c. Place and secure anchorage devices.
 - 1) Design each fastener and support to carry the load indicated and according to details.
 - 2) Use setting drawings, templates, diagrams, instructions, and directions for the items to be embedded to properly locate these items.
 - 3) Install anchor bolts to the elevations required for proper attachment to the automatic transfer switches.
 - 4) Cast anchor-bolt inserts into the concrete bases.

3.03 INSTALLATION

- A. Floor-Mounted Switches:
 - 1. Anchor floor-mounted switches to the floor by bolting.
 - 2. Install electrical devices furnished by the equipment manufacturers but not specified to be factory mounted.
- B. Install the automatic transfer switches in accordance with the automatic transfer switch manufacturer's installation instructions.
 - 1. Submit the automatic transfer switch manufacturer's written installation instructions to the Program/Project Manager for information.
- C. Annunciator and Control Panel Mounting:
 - 1. Unless otherwise indicated in the Contract Documents, mount the annunciator and control panels flush in the wall.
- D. Set the field-adjustable intervals and delays, relays, and the engine exerciser clock.
- E. Special Techniques:
 - 1. Identification:
 - a. Identify the components and provide warning signs in accordance with the requirements specified in Section 16075, Electrical Identification.
- F. Systems Integration:
 - 1. Wiring to Remote Components:
 - a. Provide wiring to remote components that matches the type and number of cables and conductors to the control and communication requirements of the transfer switches as recommended by manufacturer.
 - b. If it is necessary to increase raceway sizes in order to accommodate the required wiring, do so at no increase in the Contract Price.



2. Ground the automatic transfer switch equipment in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
3. Connect the automatic transfer switch wiring in accordance with the requirements specified in Section 16120, Conductors and Cables.

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the automatic transfer switches are being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Testing Agency Responsibilities:
 - a. Field Quality-Control Reports:
 - 1) After installing the equipment and after the electrical circuitry has been energized, have the Testing Agency employed by the Contractor test the equipment for compliance with specified requirements by performing the tests specified herein, and preparing a certified written Field Quality-Control Report for each test conducted to record the following information pertaining to the test:
 - a) The automatic transfer switches included in the testing.
 - b) Test procedures used to perform the testing.
 - c) Test results that comply with the requirements specified.
 - d) Test results that do not comply with the specified requirements, and corrective action taken to achieve compliance with the requirements.
 - (1) Note deficiencies detected, the remedial action taken, and observations after remedial action.
 - 2) Have the Testing Agency record the adjustable relay settings and measured insulation resistances, time delays, and other values and observations in the Field Quality-Control Reports.



- b. Coordinate the Site tests with the tests for diesel electric generators provided under Section 16234, Diesel Electric Generators, and run the tests concurrently.
 - c. Furnish test instruments that have been calibrated within the last 12 months, traceable to standards of the National Institute of Standards and Technology (NIST), and adequate for making positive observation of the test results.
 - 1) Make the calibration records available for examination upon request.
 - d. Test Labeling:
 - 1) Have the Testing Agency attach a label or tag to each tested component indicating satisfactory completion of the tests for that component.
 - a) On satisfactory completion of the testing of each unit, have the Testing Agency attach a dated and signed "Satisfactory Test" label to the tested unit.
- 3. Insulation Resistance Test:
 - a. Test Procedure:
 - 1) Have the Testing Agency measure the phase-to-phase and phase-to-ground insulation resistance using a insulation-resistance tester.
 - a) Include external annunciation and control circuits.
 - b) Use test voltages and a procedure recommended by the diesel electric generator manufacturer.
 - 2) Check the electrical circuits for electrical continuity and short circuits.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators having insulation resistances complying with the manufacturer's specified minimum resistance pass the Insulation Resistance Test.
- 4. Ground-Fault Tests:
 - a. Test Procedure:
 - 1) Have the Testing Agency perform ground fault testing for the diesel electric generator.
 - a) Coordinate the testing of the ground-fault protective devices for power delivery from both sources.
 - 2) Verify the grounding connections, and the locations and ratings of the sensors.
 - 3) Observe the reaction of the circuit-interrupting devices when the simulated fault current is applied at sensors.
 - b. Acceptance Criteria:
 - 1) Diesel electric generators having ground fault performance as specified pass the Ground-Fault Tests.
- 5. Performance Test:
 - a. Test Procedure:



- 1) After energizing the circuits, have the Testing Agency demonstrate the interlocking sequence and operational function for each switch at least 3 times.
 - a) Simulate power failures of the normal source to the automatic transfer switches, and of the emergency source with the normal source available.
 - b) Simulate the loss of phase-to-ground voltage for each phase of the normal source.
 - c) Verify the time-delay settings.
 - d) Verify the pickup and dropout voltages by data readout or inspection of the control settings.
 - e) Test the bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f) Perform a contact-resistance test across the main contacts, and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from the other poles.
 - g) Verify the proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 - h) Perform manual transfer operation.
- b. Acceptance Criteria:
 - 1) Diesel electric generators having the performance specified pass the Performance Test.
6. NETA Acceptance Testing:
 - a. Test Procedure:
 - 1) After the automatic transfer switches are installed and the electrical circuitry has been energized, have the Testing Agency perform each electrical test for automatic transfer switches specified in ANSI/NETA ATS.
 - 2) Have the Testing Agency prepare a certified NETA Acceptance Testing Field Quality Control Report that identifies the automatic transfer switches included and documents the NETA acceptance testing, and submit the Report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Testing Agency certification of compliance with the test parameters specified in ANSI/NETA ATS constitutes acceptance of the NETA Acceptance Testing.
7. Infrared Scanning:
 - a. Test Procedure:
 - 1) Instruments and Equipment:
 - a) Have the Testing Agency furnish and use a portable infrared scanning device designed to measure temperature or to detect significant deviations from normal values.



- b) Have the Testing Agency submit a calibration record for the infrared scanning device to the Program/Project manager for information.
 - 2) Initial Infrared Scanning:
 - a) After Substantial Completion, but not more than 60 days after Final Acceptance, have the Testing Agency perform an infrared scan of each automatic transfer switch.
 - b) Remove the access panels so joints and connections are accessible to the portable infrared scanner.
 - 3) Follow-up Infrared Scanning:
 - a) Have the Testing Agency perform an additional follow-up infrared scan of each automatic transfer switch 11 months after the date of Substantial Completion.
 - 4) Have the Testing Agency prepare a certified Field Quality Control Report that identifies the automatic transfer switches checked and describes the infrared scanning results, and have the Testing Agency submit the report to the Program/Project Manager for information.
- b. Acceptance Criteria:
 - 1) Significant deviations from normal temperature values are cause for the enclosed switch or circuit breaker under test to fail the infrared scan.
- c. Inspections:
 - 1) Have the Testing Agency perform each visual and mechanical inspection and electrical test specified in ANSI/NETA ATS.
 - 2) Inspect the electrical installation for physical damage, proper installation and connection, and the integrity of barriers, covers, and safety features.
 - 3) Verify that manual transfer warnings are properly placed.
- 8. Non-Conforming Work
 - a. Correct deficiencies identified by the tests and observations, and retest the corrected units until the specified requirements are complied with.
 - b. Remove malfunctioning units, and replace them with conforming replacement units.
 - 1) Replace damaged and malfunctioning controls and equipment.
 - 2) Retest the replacement units as specified herein.

3.05 SYSTEM STARTUP

- A. Commissioning:
 - 1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 16995, Commissioning of Electrical Systems, for the sweep or scheduled lighting controls, daylight dimming controls, lighting occupancy sensors, power quality, security systems, emergency power systems, uninterruptible



power supply (UPS) systems, fire and smoke alarms, fire protection systems, communications systems, and public address/paging work pertinent to the Work of this Section.

3.06 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Training:

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain automatic transfer switches and related equipment in accordance with the requirements specified in Section 01770, Closeout Procedures.
 - a. Coordinate the training with the training for generator equipment specified in Section 16234, Diesel Electric Generators.

3.08 PROTECTION

- A. Take steps to insure that installed automatic transfer switches are protected during subsequent construction activities.

3.09 MAINTENANCE

A. Operation and Maintenance Data:

1. Furnish operation and maintenance data for each type of automatic transfer switch product and accessory for inclusion in emergency and Operation and Maintenance manuals as specified in Section 01780, Closeout Submittals.
 - a. Include the features and operating sequences, both automatic and manual, for the automatic transfer switch.
 - b. Include a list of all factory settings of relays.
 - 1) Furnish relay-setting and calibration instructions, including software, where applicable.
2. Submit the operation and maintenance data for the automatic transfer switches and accessories to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16511

INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the following interior lighting items:
 - a. Interior lighting fixtures, lamps, and ballasts.
 - b. Emergency lighting units.
 - c. Exit signs.
 - d. Lighting fixture supports.
 - e. Retrofit kits for fluorescent lighting fixtures.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 16061 - Electrical Grounding and Bonding.
 - 5. Section 16070 – Hangers and Supports.
 - 6. Section 16075 – Electrical Identification.
 - 7. Section 16120 – Conductors and Cables.
 - 8. Section 16140 – Wiring Devices.
 - 9. Section 16145 – Lighting Control Devices.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. BF: Ballast factor.
 - 2. CCT: Correlated color temperature.
 - 3. CRI: Color-rendering index.
 - 4. HID: High-intensity discharge.
 - 5. LED: Light-emitting diode.
 - 6. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 7. LER: Luminaire efficacy rating.
 - 8. NVLAP: National Volunteer Laboratory Accreditation Program.



B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Lumen: A metric unit for luminous flux, and defined as the luminous flux emitted in a solid angle of one steradian by a point source having a uniform intensity of one candela; for the purposes of this Section the measured output of the lamp, luminaire, or both.
3. Luminaire: Complete lighting fixture, including the ballast housing if provided.

C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI_ANSLG C78.41 - American National Standard for Electric Lamps - Guidelines for Low Pressure Sodium Lamps.
 - b. ANSI_ANSLG C78.42 - American National Standard for Electric Lamps – High-Pressure Sodium Lamps.
 - c. ANSI_ANSLG C78.43 - American National Standard for Electric Lamps – Single-Ended Metal Halide Lamps.
 - d. ANSI C82.1 - American National Standard for Lamp Ballast – Line Frequency Fluorescent Lamp Ballast.
 - e. ANSI C82.4 - American National Standard for Lamp Ballasts -- Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
 - f. ANSI C82.11 Consolidated - American National Standard for Lamp Ballasts – High Frequency Fluorescent Lamp Ballasts - Supplements.
2. ASTM International (ASTM):
 - a. ASTM A 580/A 580M - Standard Specification for Stainless Steel Wire.
 - b. ASTM A 641/A 641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
4. FM Approvals LLC (FM):
 - a. The Approval Guide, www.approvalguide.com.
5. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C62.41.1 - IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - b. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
6. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
7. Illuminating Engineering Society (IESNA):
 - a. IESNA Measurement Testing and Calculation Guides.
8. National Electrical Manufacturers Association (NEMA):



- a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- b. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- c. NEMA LE 5 - Procedure for Determining Luminaire Efficiency Ratings for Fluorescent Luminaires.
- d. NEMA LE 5A - Procedure for Determining Luminaire Efficiency Ratings for Commercial, Non-residential Downlight Luminaires.
- 9. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code® (NEC).
- 10. National Institute of Standards and Technology (NIST):
 - a. Standards Services Division,
<http://ts.nist.gov/standards/accreditation/index.cfm>:
 - 1) NIST Handbook 150 – National Voluntary Laboratory Accreditation Program Procedures and General Requirements.
 - 2) NIST Handbook 150 Checklist.
 - 3) NIST Handbook 150-1 – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products.
 - 4) NIST Handbook 150-1 Checklist.
 - 5) NIST Handbook 150-1A – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products – Solid State Lighting.
 - 6) NIST Handbook 150-1A Checklist.
- 11. Underwriters Laboratories, Inc. (UL):
 - a. UL 924 - Standard for Emergency Lighting and Power Equipment.
 - b. UL 935 - Standard for Fluorescent-Lamp Ballasts.
 - c. UL 1029 - Standard for High Intensity-Discharge Lamp Ballasts.
 - d. UL 1598 -Luminaires.
- 12. United States Government:
 - a. Federal Communications Commission:
 - 1) 47 CFR 18 – Industrial, Scientific, and Medical Equipment.
 - b. U. S. Department of Defense (DOD):
 - 1) Military Specifications:
 - 1) MIL-STD-461E - Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.
- 13. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the layout and installation of lighting fixtures and suspension systems with other construction that penetrates ceilings or is supported by the ceilings, including HVAC equipment, fire-suppression system, and partition assemblies.
 - 2. Coordination Drawings:



- a. Prepare Coordination Drawings that include reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from the installers of the items involved:
 - 1) Lighting fixtures.
 - 2) Suspended ceiling components.
 - 3) Partitions and millwork that penetrate the ceiling or extend to within 12 inches (305mm) of the plane of the luminaires.
 - 4) Ceiling-mounted projectors.
 - 5) Structural members to which suspension systems for lighting fixtures will be attached.
 - 6) Other items in the finished ceiling, including the following:
 - (1) Air outlets and inlets.
 - (2) Speakers.
 - (3) Sprinklers.
 - (4) Smoke and fire detectors.
 - (5) Occupancy sensors.
 - (6) Access panels.
 - 7) Perimeter moldings.
- b. Submit the Coordination Drawings to the Program/Project Manager for approval.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Ballasts for linear fluorescent lamps.
 - 2) Ballasts for compact fluorescent lamps.
 - 3) Emergency fluorescent power units.
 - (1) Internal type power units.
 - (2) External type power units.
 - 4) Ballasts for HID lamps.
 - (1) Electromagnetic ballast for metal-halide lamps.
 - (2) Electronic ballast for metal-halide lamps.
 - (3) High-pressure sodium ballasts.
 - (4) Quartz lamp lighting controllers.
 - 5) Exit signs.
 - 6) Emergency lighting units.
 - 7) Fluorescent lamps.
 - 8) High-intensity discharge (HID) lamps:
 - (1) High-pressure sodium lamps.
 - (2) Metal-halide lamps.



- (3) Pulse-start, metal-halide lamps.
 - (4) Ceramic, pulse-start, metal-halide lamps.
 - (5) Low-pressure sodium lamps.
 - 9) LED Luminaires:
 - (1) Components: UL 8750 recognized or listed as acceptable.
 - (2) Tested in accordance with IES LM-79 and IES LM-80
 - (3) LED Estimated useful life: Minimum of 50,000 hours at 70% lumen maintenance, calculated based on IES LM-80 test data.
 - 10) Lighting Fixture Support Components
 - 11) Retrofit kits for fluorescent lighting fixtures:
 - (1) Reflector kits.
 - (2) Ballast and lamp change kits.
 - b. Shop Drawings:
 - 1) Coordination Drawings.
 - 2) Nonstandard or custom lighting fixtures.
 - c. Samples:
 - 1) Lighting fixtures.
 - d. Certificates:
 - 1) Manufacturer's Certificates of Compliance for each type of ballast for bi-level and dimmer-controlled fixtures.
 - 2) Manufacturer's Certificates of Compliance for photometric data.
 - e. Qualification Statements:
 - 1) Evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Lighting fixture manufacturer's installation instructions.
 - b. Site Quality Control Submittals:
 - 1) Emergency Lighting Test Report.
- C. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for lighting equipment and fixtures.
 - b. Warranty Documentation:
 - 1) Emergency Lighting Unit Batteries' Warranty.



- 2) Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries' Warranty.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare interior lighting products that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - 1) Lamps:
 - (1) For each type and rating of lamp installed, furnish 10 spare lamps for every 100 lamps installed, but not less than one of each type and rating.
 - 2) Plastic Diffusers and Lenses:
 - (1) For each type and rating of plastic diffuser and lens installed, furnish 1 spare plastic diffuser or lens for every 100 plastic diffusers or lens installed, but not less than one of each type and rating.
 - 3) Fluorescent-fixture-mounted, emergency battery pack:
 - (1) Furnish 1 spare fluorescent-fixture-mounted, emergency battery pack for every 20 emergency lighting units installed.
 - 4) Ballasts:
 - (1) For each type and rating of ballast installed, furnish 1 spare ballast for every 100 ballasts installed, but not less than one of each type and rating.
 - 5) Globes and Guards:
 - (1) For each type and rating of globe and guard installed, furnish 1 spare globe or guard for every 20 globes or guards installed, but not less than one of each type and rating.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Luminaire Photometric Data Testing Laboratory Qualifications:
 - a. Procure products from manufacturers participating in the National Volunteer Laboratory Accreditation Program (NVLAP), and which have manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products – Solid State Lighting, as specified in the appropriate handbooks and checklists.



- 1) Submit evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program to the Program/Project Manager for approval.

B. Certifications:

1. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - 1) Such evidence may consist of either a printed mark on the data or a separate listing card.
 - b. FM Approvals LLC Compliance:
 - 1) For hazardous locations, provide lighting fixtures listed and labeled for the indicated class and division of hazard by FM Approvals LLC.
 - c. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
 - 1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Program/Project Manager.
2. Manufacturer's Certificates of Compliance:
 - a. For each type of ballast for bi-level and dimmer-controlled fixtures, submit Manufacturer's Certificates of Compliance wherein the manufacturer of these items certifies that they comply with the specified requirements, to the Program/Project Manager for approval.
 - b. For each type of fixture, submit Manufacturer's Certificates of Compliance for photometric data and adjustment factors based on laboratory tests complying with IESNA Lighting Measurements Testing & Calculation Guides, certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products, to the Program/Project Manager for approval.

C. Site Samples:

1. For each lighting fixture indicated in the Light Fixture Schedule on the Contract Drawings, submit a Sample fixture each of which includes the following items:



- a. Lamps and ballasts, installed.
 - b. Cords and plugs.
 - c. Pendant support system.
- D. Mock-Ups:
 - 1. If room or module mock-ups are required, provide interior lighting fixtures complete with power and control connections for the mock-ups.
 - a. Obtain the Program/Project Manager's approval of the fixtures for the mockups before installing them in the mock-ups.
 - b. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 1) If mock-ups are installed as part of the building rather than erected separately, approved fixtures in the mock-ups may become part of the completed Work if they have remained undisturbed at the time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver lighting fixtures in a clean, undamaged condition.
 - 2. Inspect lighting fixtures for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 - 1. Handle lighting fixtures in accordance with the manufacturer's written instructions.
 - 2. Follow the manufacturer's written instructions for storing the lighting fixtures.
- C. Packaging Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

- A. Extended Correction Period:
 - 1. Emergency Lighting Unit Batteries' Warranty:
 - a. Warrant the emergency lighting unit batteries' materials and workmanship against failures within the 10 year period after the Date of Substantial Completion.
 - 1) Warrant the emergency lighting unit batteries under a full warranty applicable during the first year, and under a prorated warranty applicable during the remaining 9 years.
 - b. Submit the written Emergency Lighting Unit Batteries' Warranty on the manufacturer's standard form in which the manufacturer of the battery-powered emergency lighting units agrees to repair or replace



components of the rechargeable batteries that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.

- 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.
2. Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries' Warranty:
 - a. Warrant the emergency fluorescent ballast and self-powered exit sign batteries' materials and workmanship against failures within the 7 year period after the Date of Substantial Completion.
 - 1) Warrant the emergency fluorescent ballast and self-powered exit sign batteries under a full warranty applicable during the first year, and under a prorated warranty applicable during the remaining 6 years.
 - b. Submit the written Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries' Warranty on the manufacturer's standard form in which the manufacturers of the emergency fluorescent ballast and self-powered exit sign batteries agrees to repair or replace components of the ballasts and rechargeable batteries that fail in materials or workmanship within specified warranty period to the Program/Project Manager for approval.
 - 1) Have the manufacturer's standard form signed by the Contractor and manufacturer.

PART 2 PRODUCTS

2.01 LIGHTING FIXTURES AND COMPONENTS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by the manufacturers listed in the Light Fixture Schedule on the Contract Drawings.
 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed in the Light Fixture Schedule on the Contract Drawings may be provided.
- B. Description:
 1. Regulatory Requirements:
 - a. Phoenix Building Construction Code:
 - 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC



International Building Code (IBC) as Amended by the City of Phoenix].

b. National Electrical Code (NEC):

- 1) Provide products and installation complying with requirements specified for interior lighting in NFPA 70.

C. Design Criteria:

1. Provide lighting fixtures complying with the following design criteria for the fixture type:

a. Recessed Fixtures:

- 1) Provide recessed lighting fixtures complying with the requirements for ceiling compatibility of recessed fixtures specified in NEMA LE 4.

b. Fluorescent Fixtures:

- 1) Provide fluorescent lighting fixtures complying with the requirements specified in UL 1598.
- 2) If the luminaire efficacy rating (LER) is specified in the Lighting Fixture Schedule on the Contract Drawings, test the fluorescent lighting fixtures to determine the LER in accordance with the method specified in NEMA LE 5A or NEMA LE 5A as applicable.

c. HID Fixtures:

- 1) Provide HID lighting fixtures complying with the requirements specified in UL 1598.
- 2) If the luminaire efficacy rating (LER) is specified in the Interior Lighting Fixture Schedule on the Contract Drawings, test the HID lighting fixtures to determine the LER in accordance with the method specified in NEMA LE 5B.

d. LED Luminaires:

- 1) Components: UL 8750 recognized or listed as acceptable.
- 2) Tested in accordance with IES LM-79 and IES LM-80
- 3) LED Estimated useful life: Minimum of 50,000 hours at 70% lumen maintenance, calculated based on IES LM-80 test data.

e. LED Drivers

- 1) Inrush currents not exceeding peak currents specified in NEMA 410.
- 2) Minimum efficiency/efficacy: Provide ballasts complying with all current and state ballast efficiency/efficacy standards.
- 3) Dimming Range: Continuous dimming from 100 percent to five percent relative light.
- 4) Control capability: Fully compatible with the dimming controls to be installed.

f. Metal Parts:

- 1) Provide metal parts free from burrs and sharp corners and edges.

g. Sheet Metal Components:

- 1) Unless otherwise indicated, provide steel sheet metal components.



- 2) Prevent sheet metal components from warping and sagging by providing formed and supported components.
- h. Doors, Frames, and Other Internal Access:
 - 1) Provide smooth operating doors, free from light leakage under operating conditions, and designed to permit re-lamping without requiring the use of tools.
 - 2) Provide doors, frames, lenses, diffusers, and other components designed so they do not accidentally fall during re-lamping or when secured in the operating position.
- i. Diffusers and Globes:
 - 1) Acrylic Lighting Diffusers:
 - (1) Provide 100 percent virgin acrylic plastic lighting diffusers.
 - 2) Provide UV stabilized diffusers highly resistant to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3) Lens Thickness:
 - (1) Unless otherwise indicated, provide lens thicknesses of at least 0.125 inch (3.175mm).
 - 2) Glass Diffusers and Globes:
 - 1) Unless otherwise indicated, provide annealed crystal glass diffusers and globes.
- j. Factory-Applied Labels:
 - 1) Provide factory-applied labels complying with the requirements specified in UL 1598.
 - (1) Locate the labels where they will be readily visible to service personnel, but not seen from normal viewing angles when the lamps are in place.
 - 2) Provide labels indicating the recommended lamps and ballasts, and including the following lamp and ballast characteristics:
 - (1) Include the words "USE ONLY", and insert the specific lamp type following the words.
 - 2) For fluorescent and compact fluorescent luminaires, indicate the lamp diameter code (T-4, T-5, T-8, T-12, or another code), the tube configuration (twin, quad, triple, or another configuration), the base type, and the nominal wattage.
 - 3) For high-intensity discharge (HID) luminaires, indicate the lamp type, wattage, bulb type (ED17, BD56, or another type) and coating (clear or coated), and indicate the ANSI ballast type (M98, M57, or another type).
 - 4) For fluorescent and compact fluorescent luminaires, indicate the start type (preheat, rapid start, instant start, or another type).
 - 5) For all luminaires, indicate the correlated color temperature (CCT) and color-rendering index (CRI).
- k. Electromagnetic-Interference Filters:



- 1) To suppress conducted electromagnetic interference, provide factory-installed electromagnetic-interference filters as specified by MIL-STD-461E.
- 2) Provide a filter for each ballast of each lighting fixture indicated to require a filter.
- I. Product Data:
 - 1) For each type of lighting fixture provided under this Section, submit Product Data to the Program/Project Manager for approval.
 - (1) Include data on each fixture's features, accessories, finishes, and the following:
 - (2) A physical description of each lighting fixture, including the dimensions of each.
 - (3) Identification of emergency lighting units, and including information regarding the unit's battery and charger.
 - (4) Ballast information, including the ballast factor (BF).
 - (5) Energy-efficiency data.
 - 2) Fixture life; fixture output, including its lumens, correlated color temperature (CCT), and color-rendering index (CRI); and energy-efficiency data for the lamps.
 - m. Shop Drawings:
 - 1) For nonstandard or custom lighting fixtures, submit Shop Drawings to the Program/Project Manager for approval.
 - (1) Include plans, elevations, sections, details, and attachments to other work.
 - 2) Detail equipment assemblies; and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3) Wiring diagrams for power, signal, and control wiring.
- D. Materials:
 1. Ballasts for Linear Fluorescent Lamps:
 - a. Provide electronic ballasts for linear fluorescent lamps complying with the requirements specified in UL 935 and ANSI C82.11 Consolidated, and designed for the type and quantity of lamps served.
 - 1) Provide ballasts designed for the full light output, unless another ballast factor (BF), dimmer, bi-level control, or tri-level control is indicated.
 - b. Disconnecting Means:
 - 1) Provide ballasts designed with integral disconnecting means as specified in section 410.73(G) of NFPA 70.
 - c. Sound Rating:
 - 1) Provide ballasts having a Class A sound.
 - d. Total Harmonic Distortion Rating:



- 1) Provide ballasts having a total harmonic distortion rating Less than 20 percent.
- e. Transient Voltage Protection:
 - 1) Provide ballasts having transient voltage protection complying with the requirements for Category A or better protection specified in IEEE C62.41.1 and IEEE C62.41.2.
- f. Operating Frequency:
 - 1) Provide ballasts having an operating frequency of 42 kilohertz or higher.
- g. Lamp Current Crest Factor:
 - 1) Provide ballasts having a lamp current crest factor of 1.7 or less.
- h. Ballast Factor (BF):
 - 1) Provide ballasts having a ballast factor (BF) of 0.88 or higher.
- i. Power Factor (PF):
 - 1) Provide ballasts having a 0.95 power factor or higher.
- j. Parallel Lamp Circuits:
 - 1) Provide multiple lamp ballasts that comply with the requirements specified in ANSI C82.11, and that are connected so if one or more lamps fail the full light output on the surviving lamps is maintained.
- k. Programmed-Start Ballasts:
 - 1) For luminaires controlled by occupancy sensors, provide programmed-start ballasts.
 - 2) For T5, T8, and T5HO lamps, provide electronic programmed-start ballasts complying with the requirements specified in ANSI C82.11 and with the following:
 - 3) Provide a lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 - 4) Provide automatic lamp starting after lamp replacement.
- l. Ballasts for Dimmer-Controlled Lighting Fixtures:
 - 1) For dimmer-controlled lighting fixtures, provide electronic type ballasts complying with the following requirements:
 - 2) Dimming Range:
 - (1) Provide ballasts having a dimming range of 100 to 5 percent of the rated lamp lumens.
 - 3) Ballast Input Watts:
 - 4) Provide ballasts capable of reducing the ballast input Watts to 20 percent of normal.
 - 5) Compatibility:
 - (1) Provide ballasts certified by the manufacturer for use with the specific dimming control system and lamp type indicated.
 - 6) Control:
 - (1) Coordinate the wiring from the ballast to the control device to ensure that the ballast, controller, and connecting wiring are compatible.



2. Ballasts for Compact Fluorescent Lamps:
 - a. Provide electronic-programmed rapid-start type ballasts for compact fluorescent lamps complying with the requirements specified in UL 935 and ANSI C82.11 Consolidated, and designed for the type and quantity of lamps served.
 - 1) Provide ballasts designed for the full light output, unless another ballast factor (BF), dimmer, bi-level control, or tri-level control is indicated.
 - 2) Provide a lamp end-of-life detection and shutdown circuit.
 - 1) Provide provisions for automatic lamp starting after lamp replacement.
 - b. Sound Rating:
 - 1) Provide ballasts having a Class A sound rating.
 - c. Total Harmonic Distortion Rating:
 - 1) Provide ballasts having a total harmonic distortion rating Less than 20 percent.
 - d. Transient Voltage Protection:
 - 1) Provide ballasts having transient voltage protection complying with the requirements for Category A or better protection specified in IEEE C62.41.1 and IEEE C62.41.2.
 - e. Operating Frequency:
 - 1) Provide ballasts having an operating frequency of 20 kilohertz or higher.
 - f. Lamp Current Crest Factor:
 - 1) Provide ballasts having a lamp current crest factor of 1.7 or less.
 - g. Ballast Factor (BF):
 - 1) Unless otherwise indicated in the Contract Documents, provide ballasts having a ballast factor (BF) of 0.95 or higher.
 - h. Power Factor (PF):
 - 1) Provide ballasts having a 0.95 power factor or higher.
 - i. Interference:
 - 1) Provide ballasts complying with the requirements for limitations on electromagnetic and radio-frequency interference for non-consumer equipment specified in Chapter 1, Subpart C of 47 CFR 18.
3. Emergency Fluorescent Power Units:
 - a. Internal Type Power Units:
 - 1) Provide self-contained, modular, battery-inverter power units complying with the requirements specified in UL 924, and compatible with the ballasts.
 - 2) Provide power units factory-mounted within the lighting fixture body.
 - 3) Emergency Connection:
 - (1) Provide power units capable of continuously operating one fluorescent lamp at an output of 1100 lumens each.



- (2) Connect the unswitched circuit to the battery-inverter unit and the switched circuit to the fixture ballast.
- 4) Nightlight Connection:
 - (1) Provide power units capable of operating one fluorescent nightlight lamp continuously.
- 5) Test Push Button and Indicator Light:
 - (1) Provide power units having a push button and indicator light that are visible and accessible without having to open the fixture or enter the ceiling space.
 - (2) Push Button:
 - (3) Provide power units having a push-to-test type push button in the unit housing capable of simulating the loss of normal power, and of demonstrating the unit's operability.
- 2) Indicator Light:
 - (1) Provide power units having an LED indicator light that indicates normal power on.
 - (2) Connect the LED indicator light so it indicates a trickle charge by displaying a normal glow, and indicates charging at the end of the discharge cycle by displaying a bright glow.
- 6) Battery:
 - (1) Provide sealed, maintenance-free, nickel-cadmium type batteries for the power units.
- 7) Charger:
 - (1) Provide fully automatic, solid-state, constant-current type battery chargers having a sealed power transfer relay.
- 8) Remote Test:
 - (1) Provide a test switch, mounted in a remote hand-held device that initiates a coded infrared signal when the test switch is depressed.
 - (2) Provide a factory-installed infrared receiver in the tested unit that is capable of triggering a simulation of the loss of the unit's normal power supply, providing a visual confirmation of either proper or failed emergency response, when the coded infrared signal from the remote hand-held device is aimed the in the direction of the tested unit's infrared receiver.
- 9) Integral Self-Test:
 - (1) Provide a factory-installed electronic device that automatically initiates a code-required test of the unit's emergency operation at required intervals, and annunciates test failure by sounding an integral audible alarm and a flashing a red LED.



- b. External Type Power Units:
 - 1) Provide self-contained, modular, battery-inverter power units suitable for powering one or more fluorescent lamps, and complying with the requirements specified in UL 924.
 - (1) Provide power units mounted remotely from the lighting fixture.
 - 2) Emergency Connection:
 - (1) Provide power units capable of continuously operating one fluorescent lamp each.
 - (2) Connect the unswitched circuit to the battery-inverter unit and the switched circuit to the fixture ballast.
 - 3) Nightlight Connection:
 - (1) Provide power units capable of operating one fluorescent nightlight lamp in a remote fixture continuously.
 - 4) Battery:
 - (1) Provide sealed, maintenance-free, nickel-cadmium type batteries for the power units.
 - 5) Chargers:
 - (1) Provide fully automatic, solid-state, constant-current type battery chargers.
 - 6) Housings:
 - (1) Provide NEMA 1 type enclosures complying with the requirements specified in NEMA 250.
 - 7) Test Push Button:
 - (1) Provide power units having a push-to-test type push button in the unit housing capable of simulating the loss of normal power, and of demonstrating the unit's operability.
 - 8) Indicator Light:
 - (1) Provide power units having an LED indicator light that indicates normal power on.
 - (2) Connect the LED indicator light so it indicates a trickle charge by displaying a normal glow, and indicates charging at the end of the discharge cycle by displaying a bright glow.
 - 9) Remote Test:
 - (1) Provide a test switch, mounted in a remote hand-held device that initiates a coded infrared signal when the test switch is depressed.
 - (2) Provide a factory-installed infrared receiver in the tested unit that is capable of triggering a simulation of the loss of the unit's normal power supply, providing a visual confirmation of either proper or failed emergency response, when the coded infrared signal from the remote



hand-held device is aimed the in the direction of the tested unit's infrared receiver.

10) Integral Self-Test:

- (1) Provide a factory-installed electronic device that automatically initiates a code-required test of the unit's emergency operation at required intervals, and annunciates test failure by sounding an integral audible alarm and a flashing a red LED.

4. Exit Signs:

- a. Provide exit signs having the colors, visibility, luminance, and lettering size in accordance with the requirements specified in UL 924; and complying with the requirements of the Authorities Having Jurisdiction.
- b. Internally Lighted Signs:

1) Lamps for Alternating Current Operation:

- (1) Provide either 2 fluorescent lamps for each fixture, each having a rated lamp life of 20,000 hours; or LEDs having a minimum rated lamp life of 50,000 hours.

2) Self-Powered Exit Signs (Battery Type):

- (1) Provide self-powered exit signs having a battery and an integral automatic charger in a self-contained power pack.

2) Battery:

- (1) Provide sealed, maintenance-free, nickel-cadmium type batteries.

3) Charger:

- (1) Provide fully automatic, solid-state type chargers having a sealed transfer relay.

4) Operation:

- (1) Provide self-powered exit signs having a relay that automatically energizes the lamp from the battery when circuit voltage drops to 80 percent of nominal voltage or below, and that disconnects the lamps from the battery when normal voltage is restored.
- (2) Provide self-powered exit signs that automatically recharge and float the battery on the charger.

5) Test Push Button:

- (1) Provide the unit with a push-to-test type push button in the unit housing that simulates loss of normal power, and demonstrates unit operability when activated.

6) Light-Emitting Diode (LED) Indicator Light:

- (1) Provide the unit with an LED indicator light that indicates normal power on as follows:
 - (a) A normal glow indicates trickle charge.
 - (b) A bright glow indicates charging at the end of the discharge cycle.

7) Remote Test:



- (1) Provide a test switch, mounted in a remote hand-held device that initiates a coded infrared signal when the test switch is depressed.
 - (2) Provide a factory-installed infrared receiver in the tested unit that is capable of triggering a simulation of the loss of the unit's normal power supply, providing a visual confirmation of either proper or failed emergency response, when the coded infrared signal from the remote hand-held device is aimed the in the direction of the tested unit's infrared receiver.
 - 8) Integral Self-Test:
 - (1) Provide a factory-installed electronic device that automatically initiates a code-required test of the unit's emergency operation at required intervals, and annunciates test failure by sounding an integral audible alarm and a flashing a red LED.
5. Emergency Lighting Units:
 - a. Provide self-contained emergency lighting units complying with the requirements specified in UL 924.
 - 1) Battery:
 - (1) Provide sealed, maintenance-free, lead-acid type batteries for the emergency lighting units.
 - 2) Charger:
 - (1) Provide fully automatic, solid-state, type battery chargers having a sealed power transfer relay.
 - 3) Operation:
 - (1) Provide emergency lighting units having a relay that automatically energizes the lamp from the power-supply circuit voltage drops to 80 percent of nominal voltage or below, and that automatically disconnects the lamps from the battery when normal voltage is restored.
 - (2) Provide emergency lighting units that automatically recharge and float the battery on the charger.
 - 4) Test Push Button:
 - (1) Provide the unit with a push-to-test type push button in the unit housing that simulates loss of normal power, and demonstrates unit operability when activated.
 - 5) Light-Emitting Diode (LED) Indicator Light:
 - (1) Provide the unit with an LED indicator light that indicates normal power on as follows:
 - (2) A normal glow indicates trickle charge.
 - (3) A bright glow indicates charging at the end of the discharge cycle.
 - 6) Wire Guard:



- (1) Provide the unit with a heavy-chrome-plated wire guard that protects the lamp heads and fixtures.
- 7) Integral Time-Delay Relay:
 - (1) Provide the unit with an integral time-delay relay that holds the unit "on" for a fixed interval of 15 minutes when the power is restored after an outage.
- 8) Remote Test:
 - (1) Provide a test switch, mounted in a remote hand-held device that initiates a coded infrared signal when the test switch is depressed.
 - (2) Provide a factory-installed infrared receiver in the tested unit that is capable of triggering a simulation of the loss of the unit's normal power supply, providing a visual confirmation of either proper or failed emergency response, when the coded infrared signal from the remote hand-held device is aimed the in the direction of the tested unit's infrared receiver.
- 9) Integral Self-Test:
 - (1) Provide a factory-installed electronic device that automatically initiates a code-required test of the unit's emergency operation at required intervals, and annunciates test failure by sounding an integral audible alarm and a flashing a red LED.
6. Fluorescent Lamps:
 - a. Provide low mercury fluorescent lamps of the following types as indicated in the Light Fixture Schedule on the Contract Drawings, or as required by the fixture indicated there:
 - 1) T8, 32-Watt Fluorescent Lamps:
 - (1) Unless otherwise indicated, provide T8 rapid-start lamps rated for 32 Watts maximum, and having a nominal length of 48 inches (1220mm), initial minimum luminous flux of 2800 lumens, a minimum color-rendering index of CRI 75, a color temperature of 4100 degrees Kelvin, and an average rated life of 20,000 hours.
 - 2) T8, 17-Watt Fluorescent Lamps:
 - (1) Unless otherwise indicated, provide T8 rapid-start lamps rated for 17 Watts maximum, and having a nominal length of 24 inches (610mm), initial minimum luminous flux of 1300 lumens, a minimum color-rendering index of CRI 75, a color temperature of 4100 degrees Kelvin, and an average rated life of 20,000 hours.
 - 3) Compact Fluorescent Lamps:



- (1) Unless otherwise indicated, provide 4-pin T4 compact fluorescent lamps suitable for use with dimming ballasts, and having a minimum color-rendering index of CRI 80, a color temperature of 4100 degrees Kelvin, an average rated life of 10,000 hours at three hours operation per start, and the following Wattages and minimum luminous fluxes as applicable:
 - (2) 13 Watts, double or triple tube, rated 900 initial lumens.
 - (3) 18 Watts, double or triple tube, rated 1200 initial lumens.
 - (4) 26 Watts, double or triple tube, rated 1800 initial lumens.
 - (5) 32 Watts, triple tube, rated 2400 initial lumens.
 - (6) 42 Watts, triple tube, rated 3200 initial lumens.
 - (7) 57 Watts, triple tube, rated 4300 initial lumens.
 - (8) 70 Watts, triple tube, rated 5200 initial lumens.

2.02 ACCESSORIES

A. Lighting Fixture Support Components:

1. Provide lighting fixture support components complying with the requirements for channel-iron and angle-iron supports and nonmetallic channel and angle supports specified in Section 16070, Hangers and Supports, and with the following:
 - a. Single-Stem Hangers:
 - 1) Provide single-stem hangers consisting of 1/2-inch (13mm) steel tubing finished the same as the fixture, and having swivel ball fittings and a ceiling canopy.
 - b. Twin-Stem Hangers:
 - 1) Provide two, 1/2-inch (13mm) steel tubes finished the same as the fixture, and having a single canopy designed to mount a single fixture.
 - c. Wires:
 - 1) Provide 12 gage (2.68mm) soft temper, zinc-coated steel wires complying with the requirements for Class 3 wire specified in ASTM A 641/A 641M.
 - d. Wires for Humid Spaces:
 - 1) Provide 12 gage (2.68mm) annealed stainless steel wires for humid spaces complying with the requirements for Type 302 or 304 stainless steel wire specified in ASTM A 580/A 580M.
 - e. Rod Hangers:
 - 1) Provide cadmium-plated, threaded steel rod hangers having a minimum diameter of 3/16 inch (5mm).
 - f. Hook Hangers:
 - 1) Provide hook hangers consisted of an integrated assembly matched to the fixture and line voltage, and equipped with a threaded attachment, cord, and locking-type plug.



2. Retrofit Kits for Fluorescent Lighting Fixtures:
 - a. Reflector Kits:
 - 1) Provide reflector kits complying with the requirements for Type I kits specified in UL 1598, and suitable for improving the reflectivity of the fixture surfaces of two-lamp to four-lamp, surface-mounted or recessed lighting fixtures.
 - b. Ballast and Lamp Change Kits:
 - 1) Provide ballast and lamp change kits complying with the requirements for Type II kits specified in UL 1598, and suitable for changing existing ballast, lamps, and sockets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the areas to receive lighting fixtures and the conditions there for compliance with requirements.
- B. Evaluation and Assessment:
 1. Proceed to install the lighting fixtures only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the lighting fixtures.

3.03 INSTALLATION

- A. Lighting Fixtures:
 1. Install lighting fixtures in accordance with the manufacturer's installation instructions.
 - a. Submit the lighting fixture manufacturer's installation instructions to the Program/Project Manager for information.
 2. Unless otherwise indicated, set the lighting fixtures level, plumb, and square with the ceilings and walls.
 3. Install lamps in each luminaire.
- B. Remote Ballasts:
 1. Do not mount remote ballasts further from their fixtures than allowed by the ballast manufacturer's recommendations.
 - a. Verify with the ballast manufacturers, the maximum distance between the ballast and the luminaire.
 2. Pulse-Start Ballasts:



- a. Remote mounting distances for some pulse-start ballasts might be as short as 60 inches (150mm).
- C. Lay-in Ceiling Lighting Fixtures Supports:
 - 1. Use the lay-in ceiling grid as a support element.
 - a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture.
 - 1) Locate the ceiling support system rods or wires not more than 6 inches (150mm) from the lighting fixture corners.
 - b. Support Clips:
 - 1) Fasten the support clips to the lighting fixtures and to the ceiling grid members at or near each fixture corner, using clips that are UL-listed for the application.
 - c. Fixtures Having Sizes Less Than the Ceiling Grid Dimensions:
 - 1) Install fixtures having sizes less than the ceiling grid dimensions as indicated on the reflected ceiling plans, or center these fixtures in the acoustical panels.
 - 1) Support the fixtures independently with at least two 3/4-inch (20mm) metal channels spanning and secured to the ceiling tees.
 - d. Install at least one independent support rod or wire from the structure to a tab on the lighting fixture.
 - 1) Provide wire or rod having a breaking strength based on the weight of the fixture and a safety factor of 3.
- D. Suspended Lighting Fixture Supports:
 - 1. Pendants and Rods:
 - a. Brace pendants and rods that are longer than 48 inches (1200mm) to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures:
 - a. Provide twin-stem hangers to suspend stem-mounted, single-unit fixtures.
 - 3. Continuous Rows:
 - a. Provide tubing or a stem for wiring at one point, and provide tubing or rod to suspend each unit length of the fixture chassis, including a tube or rod at each end.
 - 4. Do not use the grid as a support for pendant luminaires.
 - a. Connect support wires or rods to the building structure.
- E. Special Techniques:
 - 1. Identification:
 - a. Install labels having the panel and circuit numbers on concealed junction and outlet boxes for the lighting fixtures.
 - b. Comply with the requirements for identification specified in Section 16075, Electrical Identification.
- F. Interface with Other Work:



1. Connect wiring to the lighting fixtures in accordance with the requirements specified in Section 16120, Conductors and Cables.
2. Install lighting switches and controls in accordance with the requirements specified in Section 16140, Wiring Devices, and Section 16145, Lighting Control Devices.
3. Ground the lighting fixtures in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.

3.04 RE-INSTALLATION

- A. Temporary Lighting:
 1. If necessary and approved by the Program/Project Manager, permanent luminaires may be used for temporary lighting.
 - a. Install and energize the minimum number of permanent luminaires necessary.
 - b. When construction is sufficiently complete, remove, disassemble, and thoroughly clean the luminaires used for temporary lighting; then install new lamps in the luminaires and reinstall the luminaires.

3.05 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Emergency Lighting Test:
 - a. Test Procedure:
 - 1) Interrupt the power supply of each emergency lighting fixture to demonstrate the proper operation of the emergency lighting fixtures.
 - (1) Verify the transfer from normal power to battery power, and the retransfer to normal power.
 - 2) Prepare a written Emergency Lighting Test Report of the tests, inspections, observations, and verifications that documents and interprets the results.
 - (1) Submit the Emergency Lighting Test Report to the Program/Project Manager for information.
 - b. Acceptance Criteria:
 - 1) Emergency lighting fixtures operating as specified pass the Emergency Lighting Test.
 2. Inspections:
 - a. Inspect each installed fixture for damage.
- B. Non-Conforming Work
 1. Replace damaged fixtures and components.

3.06 SYSTEM STARTUP

- A. Prior to occupancy by Owner, burn-in all lamps that require a specific aging period to operate properly.



1. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.07 ADJUSTING

- A. Occupancy Adjustments:
 1. When requested within 12 months of date of Substantial Completion, provide on-site assistance to adjust aimable luminaires to suit the actual occupied conditions.
 - a. Provide for up to 2 visits to the Site during other-than-normal occupancy hours for this purpose
 - b. Some of this work may be required to be performed after dark.
 2. Adjust the aimable luminaires in the presence of the Program/Project Manager.
- B. After adjustments are made to the lighting system, retest the adjusted components to demonstrate their compliance with the standards.

3.08 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.09 PROTECTION

- A. Take steps to ensure that installed lighting equipment and fixtures are protected during subsequent construction activities.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
 1. Furnish operation and maintenance data for lighting equipment and fixtures for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. Provide a list of all lamp types used on the Contract using ANSI and manufacturers' codes to identify each.
 2. Submit the operation and maintenance data for the panelboards and components to the Program/Project Manager for information.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.



SECTION 16521

EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes requirements for exterior lighting, including the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 03100 - Concrete Forms and Accessories.
 - 6. Section 03200 - Concrete Reinforcement.
 - 7. Section 03300 - Cast-In-Place Concrete.
 - 8. Section 03600 - Grouts.
 - 9. Section 16061 - Electrical Grounding and Bonding.
 - 10. Section 16130 - Raceway and Boxes.
 - 11. Section 16511 - Interior Lighting.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AC: Alternating electric current.
 - 2. CCT: Correlated color temperature.
 - 3. CRI: Color-rendering index.
 - 4. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 5. HID: High-intensity discharge.
 - 6. LER: Luminaire efficacy rating.



7. LED: Light Emitting Diode
8. NIST: An acronym for National Institute of Standards and Technology, a Federal agency that develops and promotes measurements, standards, and technology.
9. NRTL: Nationally recognized testing laboratory.
10. NVLAP: National Volunteer Laboratory Accreditation Program.
11. RMS: Root-mean-square.
12. UV: Ultraviolet.

B. Definitions:

1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Luminaire: The complete lighting fixture, including the ballast housing if provided.
3. Nationally Recognized Testing Laboratory (NRTL): An organization which is recognized by the Occupational Safety and Health Administration (OSHA), and which tests for safety, and lists or labels or accepts, equipment or materials which meet the criteria specified in 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
4. Pole: Luminaire support structure, including a tower used for large area illumination.
5. Standard: Same definition as for "Pole".

C. Reference Standards:

1. Aluminum Association (AA):
 - a. DAF-45 – Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA):
 - a. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
3. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO LTS-5 - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
4. American National Standards Institute (ANSI):
 - a. ANSI_ANSLG C78.41 - American National Standard for Electric Lamps - Guidelines for Low Pressure Sodium Lamps.
 - b. ANSI_ANSLG C78.42 - American National Standard for Electric Lamps – High-Pressure Sodium Lamps.
 - c. ANSI_ANSLG C78.43 - American National Standard for Electric Lamps – Single-Ended Metal Halide Lamps.
 - d. ANSI C82.1 - American National Standard for Lamp Ballast – Line Frequency Fluorescent Lamp Ballast.



- e. ANSI C82.4 – American National Standard for Lamp Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
- f. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment, Locking –Type Photocontrol Devices and Mating Receptacles – Physical and Electrical Interchangeability and Testing.
- 5. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE/IESNA 90.1-2007 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
- 6. ASTM International (ASTM):
 - a. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
 - b. ASTM A 48/A 48M - Standard Specification for Gray Iron Castings.
 - c. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - e. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - f. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - g. ASTM B 429/B 429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - h. ASTM B 660 - Standard Practices for Packaging/Packing of Aluminum and Magnesium Products.
- 7. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
- 8. Illuminating Engineering Society of North America (IESNA):
 - a. IESNA LM-5 - IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations.
 - b. IESNA LM-50 - IESNA Guide for Photometric Measurements of Roadway Lighting Installations [*withdrawn*].
 - c. IESNA LM-52 - IESNA Guide for Photometric Measurements of Roadway Sign Installations.
 - d. IESNA LM-64 - IESNA Guide for the Photometric Measurements of Parking Areas.
 - e. IESNA LM-72 - IESNA Guide for Directional Positioning of Photometric Data.
 - f. ANSI/IESNA RP-8 – Roadway Lighting.
 - g. IESNA RP-33 – Lighting for Exterior Environments.
- 9. Institute of Electrical and Electronics Engineers (IEEE):
 - a. ANSI/IEEE C2– National Electrical Safety Code® (NESC).
 - b. IEEE C62.41.1 – IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.



- c. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
- 10. International Code Council (ICC):
 - a. ICC International Building Code (IBC) as Amended by the City of Phoenix.
- 11. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. Architectural Metal Products Division (AMP):
 - 1) NAAMM AMP 500 – Metal Finishes Manual for Architectural and Metal Products.
- 12. National Electrical Manufacturers Association (NEMA):
 - a. NEMA LE 5 – Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires.
 - b. NEMA LE 5A – Procedure for Determining Luminaire Efficacy Ratings for Commercial, Non-residential Downlight Luminaires.
 - c. NEMA LE 5B – Procedure for Determining Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires.
 - d. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- 13. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code® (NEC).
- 14. National Institute of Standards and Technology (NIST):
 - a. Standards Services Division,
<http://ts.nist.gov/standards/accreditation/index.cfm>:
 - 1) NIST Handbook 150 – National Voluntary Laboratory Accreditation Program Procedures and General Requirements.
 - 2) NIST Handbook 150 Checklist.
 - 3) NIST Handbook 150-1 – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products.
 - 4) NIST Handbook 150-1 Checklist.
 - 5) NIST Handbook 150-1A – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products – Solid State Lighting.
 - 6) NIST Handbook 150-1A Checklist.
- 15. The Society for Protective Coatings (SSPC):
 - a. SSPC Steel Structures Painting Manual.
 - 1) SSPC-SP 1 – Solvent Cleaning.
 - 2) SSPC-SP 5/NACE No. 1 – White Metal Blast Cleaning.
 - 3) SSPC-SP 8 – Pickling.
- 16. Underwriters Laboratories, Inc. (UL):
 - a. UL 773 – Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting.
 - b. UL 773A – Standard for Nonindustrial Photoelectric Switches for Lighting Control.
 - c. UL 1029 – Standard for High Intensity-Discharge Lamp Ballasts.
 - d. UL 1598 – Luminaires.
- 17. United States Government:



- a. Occupational Safety and Health Administration (OSHA):
 - 1) 29 CFR 1910 Occupational Health and Safety Standards.
- 18. Institute for Sustainability Infrastructure (ISI)
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with the Program/Project Manager and the Phoenix Sky Harbor International Airport to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing performed by the Testing and Inspection Agency, the Approved Agency, and the City, prior to incorporating items requiring testing by them into the Work.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Gaskets.
 - 2) Luminaire-mounted photoelectric relays.
 - 3) Ballasts for fluorescent lamps.
 - 4) Ballasts for high-intensity discharge (HID) lamps.
 - 5) High-intensity discharge (HID) lamps.
 - 6) LED Luminaires and associated driver and control equipment.
 - 7) Light poles and support components.
 - 8) Labels.
 - b. Shop Drawings:
 - 1) Luminaires, poles, support components, and foundations.
 - 2) Wiring diagrams for power, signal, and control wiring.
 - c. Certificates:
 - 1) Pole and Support Component Certificates.
 - d. Delegated Design Submittals:
 - 1) Design calculations for the strength of screw foundations and soil conditions.
 - e. Qualification Statements:
 - 1) Professional Engineer's qualifications.
 - 2) Evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program.

- B. Informational Submittals:



1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Luminaire manufacturer's light pole installation recommendations and instructions.
- C. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for exterior luminaires and light poles.
 - b. Warranty Documentation:
 - 1) Luminaire Warranty.
 - 2) Metal Corrosion Warranty.
 - 3) Color Retention Warranty.
 - 4) Light Pole Warranty.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare exterior lighting products that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Lamps:
 - (1) For each type and rating of lamp installed, furnish 1 spare lamp for every 100 lamps installed, but not less than one of each type and rating.
 - b) Glass and Plastic Lenses, Covers, and Other Optical Parts:
 - (1) For each type and rating of glass and plastic lens, cover, and other optical part installed, furnish 1 spare glass and plastic lens, cover, or other optical part for every 100 glass and plastic lens, cover, or other optical part installed, but not less than one of each type and rating.
 - c) Ballasts/Drivers:
 - (1) For each type and rating of ballast/Driver installed, furnish a spare for every 100 installed, but not less than one of each type and rating.
 - d) Globes and Guards:
 - (1) For each type and rating of globe and guard installed, furnish 1 spare globe or guard for every 20 globes or guards installed, but not less than one of each type and rating.



1.05 QUALITY ASSURANCE

A. Regulatory Agency Approvals:

1. Special Inspections:

- a. Under the ICC International Building Code (IBC) as Amended by the City of Phoenix, special inspections by the code-required Approved Agency are necessary to obtain approval of the Work of this Section.
- b. Code-Required Approved Agency for Performing Special Inspections:
 - 1) To perform the special inspections required by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Program/Project Manager acting as the Phoenix Sky Harbor International Airport's agent will employ an independent Approved Agency.
- c. Periodic Special Inspections will be performed during the installation of exterior lighting foundations.

2. Testing and Inspection Agencies:

- a. To perform testing and inspections not considered special inspections by the ICC International Building Code (IBC) as Amended by the City of Phoenix, the Phoenix Sky Harbor International Airport will employ both an independent Testing and Inspection Agency and the City of Phoenix Testing Laboratory.

B. Qualifications:

1. Luminaire Photometric Data Testing Laboratory Qualifications:

- a. Procure products from manufacturers participating in the National Volunteer Laboratory Accreditation Program (NVLAP), and which have manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products – Solid State Lighting, as specified in the appropriate handbooks and checklists.
 - 1) Submit evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program to the Program/Project Manager for approval.

2. Professional Engineer's Qualifications:

- a. Employ an independent Professional Engineer, registered in the State of Arizona, who is qualified to perform design calculations for the strength of screw foundations and the soil conditions required under this Section.
- b. Submit the Professional Engineer's qualifications to the Program/Project Manager for approval.

C. Certifications:

1. Listing and Labeling of Electrical Components, Devices, and Accessories:



- a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
 - 1) Provide products marked with their intended use or classification.
 - 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.
2. Pole and Support Component Certificates:
 - a. Furnish Pole and Support Component Certificates, signed by the manufacturers of the poles and supports, certifying that the poles and supports are designed to comply with the requirements for loads specified in AASHTO LTS-5, and that the load imposed by the luminaire and attachments has been included in design.
 - 1) Furnish the certification on the basis of design calculations performed by a qualified Professional Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Light Poles:

- a. Package aluminum light poles for shipping in accordance with the requirements specified in ASTM B 660.

B. Storage and Handling Requirements:

1. Light Poles:

- a. Store light poles on decay-resistant-treated skids at least 12 inches (300mm) above grade and vegetation.
 - 1) Support light poles to prevent distortion, and arrange the light poles to promote free air circulation.
- b. Handle wood poles so they will not be damaged.
 - 1) Do not use pointed tools that can indent the pole surface more than 1/4 inch (6mm) deep.
 - 2) Do not apply tools to the section of the pole to be installed below the ground line.
- c. Retain factory-applied pole wrappings on fiberglass, laminated wood, and metal poles until right before pole installation.
 - 1) Handle poles with nonmetallic finishes using web fabric straps.

C. Packaging Waste Management:



1. Dispose of packaging waste in accordance with the requirements of the Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

1.07 WARRANTY

A. Special Warranty:

1. Provide the special warranties for the exterior lighting listed herein on the manufacturer's standard form in which the manufacturer of the exterior lighting units agrees to repair or replace components of exterior lighting units that fail in materials or workmanship, and that corrode, fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation, within specified warranty period:
 - a. Special warranty exclusions from coverage may include lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations.
2. Luminaire Warranty:
 - a. Furnish a Luminaire Warranty effective during the warranty period including the 5 years after the date of Substantial Completion.
3. Metal Corrosion Warranty:
 - a. Furnish a Metal Corrosion Warranty effective during the warranty period including the 5 years after the date of Substantial Completion.
4. Color Retention Warranty:
 - a. Furnish a Color Retention Warranty effective during the warranty period including the 5 years after the date of Substantial Completion.
5. Light Pole Warranty:
 - a. Furnish a Light Pole Warranty in which the manufacturer of the exterior lighting units agrees to repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than the period including the 3 years after the date of Substantial Completion.

PART 2 PRODUCTS

2.01 EXTERIOR LIGHTING ASSEMBLIES

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide the product manufactured by the manufacturer listed on the Contract Drawings.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed on the Contract Drawings may be provided.



B. Description:

1. Regulatory Requirements:

a. Phoenix Building Construction Code:

- 1) Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments [ICC International Building Code (IBC) as Amended by the City of Phoenix].

b. National Electrical Code (NEC):

- 1) Provide products and installation complying with the requirements specified for external lighting in NFPA 70.

c. National Electrical Safety Code (NESC):

- 1) Provide products and installation complying with requirements specified for exterior lighting in ANSI/IEEE C2.

2. Sustainability Requirements:

a. Envision Credits:

- 1) Provide exterior lighting that is capable of qualifying the Project for ENVISION Credits RA2.1 – Reduce Energy Consumption and RA2.3 – Commission and Monitor Energy Systems.
 - a) Provide products and installation that meet the performance requirements established in the contract documents for purposes of maintaining the as designed energy reduction in accordance with the Appendix D in ANSI/ASHRAE/IESNA 90-2007.
 - b) Only light areas required for safety and comfort.
 - c) Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined in ASHRAE/IESNA 90.1.
 - d) Follow the requirements specified for lighting zone LZ4 - High (Major City Centers, Entertainment Districts) in accordance with the requirements specified in IESNA RP-33:
 - (1) Provide exterior lighting so all Site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.60 horizontal and vertical footcandles at the Site boundary, and no greater than 0.01 horizontal footcandles 15 feet beyond the Site.
 - (2) Document that no more than 10 percent of the total initial designed Site lumens are emitted at an angle of 90 degrees or higher from nadir (straight down).
 - (3) For Site boundaries that abut public right-of-way, light trespass requirements may be met relative to the curb line instead of the Site Boundary.

C. Performance:

1. Lateral Light Distribution Patterns:

- a. If the Exterior Lighting Device Schedule or details on the Contract Drawings include lighting units or luminaires having a Type I, II, III, IV,



or V distribution pattern, provide these lighting units and luminaires having lateral light distribution patterns complying with the requirements specified in ANSI/IESNA RP-8.

2. Luminaire Efficacy Rating (LER):
 - a. Where the luminaire efficacy rating (LER) is indicated, provide exterior lighting luminaires having the LER specified when tested in accordance with the appropriate method specified for the following fixture types:
 - 1) Fluorescent Fixtures: NEMA LE 5 or NEMA LE 5A as applicable.
 - 2) Incandescent Fixtures: NEMA LE 5A.
 - 3) High-Intensity Discharge (HID) Fixtures: NEMA LE 5B.
 - 4) LED Fixtures: NEMA 410 as applicable.
3. Reflecting Surfaces:
 - a. Unless otherwise indicated, provide reflecting surfaces having the following minimum reflectance:
 - 1) White Surfaces: 85 percent.
 - 2) Specular Surfaces: 83 percent.
 - 3) Diffusing Specular Surfaces: 75 percent.

D. Design Criteria:

1. Building-Mounted Exterior Luminaires:
 - a. For exterior luminaires normally mounted on exterior surfaces of buildings, provide luminaires complying with the requirements specified in Section 16511, Interior Lighting.
2. Exterior Luminaires:
 - a. Provide exterior luminaires complying with the requirements specified in UL 1598, and that are listed and labeled for installation in wet locations by a nationally recognized testing laboratory (NRTL) acceptable to the Authorities Having Jurisdiction.
 - b. Housings:
 - 1) Provide rigidly formed, weather-tight and light-tight enclosures that will not warp, sag, or deform in use.
 - 2) For enclosed luminaires, provide a filter/breather.
 - c. Doors, Frames, and Other Internal Access:
 - 1) Provide smooth operating doors, free of light leakage under operating conditions, and designed to permit re-lamping without the use of tools.
 - 2) Provide doors, frames, lenses, diffusers, and other components designed not to accidentally fall during re-lamping and when secured in the operating position.
 - 3) Provide removable doors that allow for cleaning and replacing lenses.
 - 4) Provide doors designed to disconnect the ballast when the door opens.
 - d. Light Shields:



- 1) Provide factory-installed and field-adjustable metal baffles arranged to block light distribution to that portion of the normally illuminated area or field indicated in the Contract Documents.
3. Light Pole Structural Design Criteria:
 - a. Provide light poles designed to comply with the following structural design criteria:
 - 1) Dead Load:
 - a) Provide light poles designed to accommodate a dead load consisting of the weight of the luminaire and its horizontal and vertical supports, its lowering devices, and its supporting structure, applied as specified in AASHTO LTS-5.
 - 2) Live Load:
 - a) If pole-mounted walkways or service platforms are required, provide light poles designed to accommodate a live load consisting of a single load of 500 pounds-force (2224N), distributed as specified in AASHTO LTS-5.
 - 3) Wind Load:
 - a) Provide light poles designed to accommodate a wind load consisting of the pressure of the wind on the pole and luminaire and on banners and banner arms, calculated and applied as specified in AASHTO LTS-5.
 - (1) For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in the pole selection strength analysis.
 - b) Provide light poles having adequate wind-load strength at the following heights above grade to not fail, permanently deflect, or whip in steady winds of the speed indicated:
 - (1) For poles exceeding 50 feet (15m) in height, calculate the wind load using a basic wind speed of 100 miles per hour (45m/s), and the following additional factors:
 - (a) Wind Importance Factor: 1.0.
 - (b) Minimum Design Life: 50 years.
 - (c) Velocity Conversion Factors: 1.0.
 - (2) For poles 50 feet (15m) high or less, calculate the wind load using a basic wind speed of 100 miles per hour (45m/s), and the following additional factors:
 - (a) Wind Importance Factor: 1.0.
 - (b) Minimum Design Life: 25 years.
 - (c) Velocity Conversion Factors: 1.0.
4. Light Pole Clearances:
 - a. Unless otherwise indicated on the Contract Drawings, maintain the following minimum horizontal distances from light poles to surface and underground features:
 - 1) Fire Hydrants and Storm Drainage Piping: 60 inches (1520mm).



- 2) Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3m).
 - 3) Trees: 15 feet (5m) from the tree trunk.
5. Product Data:
 - a. Prepare Product Data for each luminaire, pole, and support component, arranged in order of the lighting unit designations, and including information regarding product features, accessories, finishes, and the following:
 - 1) A physical description of luminaires, including their materials, dimensions, effective projected area, and verification of the indicated parameters.
 - 2) Details for attaching luminaires and accessories.
 - 3) Details of installation and construction.
 - 4) Luminaire materials.
 - 5) Photometric data based on laboratory testing of each luminaire type, complete with its indicated lamps, ballasts, and accessories.
 - a) Testing Agency Certified Data:
 - (1) For the indicated luminaires, furnish photometric data certified by a qualified independent testing agency.
 - (2) For the remaining luminaires, furnish photometric data certified by the manufacturer.
 - b) Manufacturer Certified Data:
 - (1) Furnish photometric data certified by manufacturer's laboratory having a current accreditation under the NIST National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 - 6) Photoelectric relays.
 - 7) Ballast and LED drivers, including energy-efficiency data.
 - 8) Lamps, including life, output, correlated color temperature (CCT), color-rendering index (CRI), lumens, and energy-efficiency data.
 - 9) Materials, dimensions, and finishes of poles.
 - 10) Means of attaching luminaires to supports, and an indication that the attachment is suitable for the components involved.
 - 11) Anchor bolts for poles.
 - 12) Manufactured pole foundations, if applicable, including screw foundations.
 - b. Submit Product Data for each luminaire, pole, and support component to the Program/Project Manager for approval.
6. Shop Drawings:
 - a. Prepare Shop Drawings for each luminaire, pole, support component, and foundation proposed for the Work of this Section.
 - 1) Include plans, elevations, sections, details, and attachments to other work.
 - a) Detail equipment assemblies, and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.



- b) Furnish anchor-bolt templates keyed to specific poles, and certified by the manufacturer.
 - 2) Wiring Diagrams:
 - a) Furnish wiring diagrams for power, signal, and control wiring.
 - b. Submit the Shop Drawings for each luminaire, pole, and support component to the Program/Project Manager for approval.
 - 7. Design Calculations:
 - a. Screw Foundations and Soil Conditions:
 - 1) Submit design calculations, certified by a qualified Professional Engineer, indicating the strength of screw foundations and the soil conditions on which they are based to the Program/Project Manager for approval.
- E. Materials:
 - 1. Plastic Parts:
 - a. Provide plastic parts having a high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- F. Components:
 - 1. Gaskets:
 - a. Provide gaskets, for sealing and cushioning lenses and refractors in luminaire doors, fabricated from heat- resistant and aging-resistant resilient material.
 - 2. Luminaire-Mounted Photoelectric Relays:
 - a. Provide luminaire-mounted photoelectric relays complying with the requirements specified in UL 773 or UL 773A.
 - b. Contact Relays:
 - 1) Provide factory mounted, single throw, contact relays designed to fail in the on position, and factory set to the turn light unit on at 1.5 foot-candles to 3 foot-candles (16lx to 32lx).
 - 2) Provide relays having a directional lens in front of the photocell to prevent artificial light sources from causing false turnoff.
 - 3) Relay having a locking-type receptacle must comply with the requirements specified in ANSI C136.10.
 - 4) For adjusting on-off set points, provide an adjustable window slide.
 - 3. Ballasts for Fluorescent Lamps:
 - a. Ballasts for Low Temperature Environments:
 - 1) For temperatures of 0 degrees Fahrenheit (minus 17 degrees Celsius) and higher, provide electromagnetic type ballasts rated for a starting and operating temperature of 0 degrees Fahrenheit (minus 17 degrees Celsius) with the lamp types indicated.
 - 2) For temperatures of minus 20 degrees Fahrenheit (minus 29 degrees Celsius) and higher, provide electromagnetic type ballasts designed for use with the lamp types indicated.
 - 3) Ballast Characteristics:



- a) Power Factor:
 - (1) Provide ballasts having a minimum power factor of 90 percent.
- b) Sound Rating:
 - (1) Provide ballasts having a Class A sound rating except provide a Class B sound rating for T12/HO ballasts.
- c) Total Harmonic Distortion Rating:
 - (1) Provide ballasts having a total harmonic distortion rating less than 10 percent.
- d) Electromagnetic Ballasts:
 - (1) Provide electromagnetic ballasts complying with the requirements specified for energy-saving, high power factor, Class P, automatic-reset thermal protection ballasts in ANSI C82.1.
- e) Case Temperature for Compact Lamp Ballasts:
 - (1) For compact lamp ballasts, provide ballasts having a maximum rated case temperature of 65 degrees Celsius.
- f) Transient-Voltage Protection:
 - (1) Provide ballasts having transient-voltage protection comply with the requirements for Category A or better protection specified in IEEE C62.41.1 and IEEE C62.41.2.
- 4) LED Drivers
 - a) Inrush currents not exceeding peak currents specified in NEMA 410.
 - b) Minimum efficiency/efficacy: Provide ballasts complying with all current and state ballast efficiency/efficacy standards.
 - c) Dimming Range: Continuous dimming from 100 percent to five percent relative light.
 - d) Control capability: Fully compatible with the dimming controls to be installed.
- 5) Low-Temperature Lamp Capability:
 - a) Provide ballasts having a low-temperature lamp capability rated for reliable starting and operation with the ballast provided at temperatures 0 degrees Fahrenheit (minus 18 degrees Celsius) and higher.
- 4. Light Poles and Support Components:
 - a. Mountings, Fasteners, and Appurtenances:
 - 1) Provide corrosion-resistant mountings, fasteners, and appurtenances compatible with support components, and that do not cause galvanic action at contact points.
 - a) Unless otherwise indicated, provide stainless-steel fasteners and mounting bolts.
 - 2) Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers:



- a) Unless otherwise indicated, provide anchor bolts, leveling nuts, bolt caps, and washers that have been hot-dip galvanized after fabrication.
 - 3) Anchor-Bolt Templates:
 - a) Provide plywood or steel anchor-bolt templates for the anchor-bolts for mounting the poles.
 - b. Handholes:
 - 1) Provide oval-shaped handholes having a clear opening of 2-1/2 inches by 5 inches (65mm by 130mm) minimum, and having covers secured by stainless-steel captive screws.
 - 2) Provide handholes on all poles, except for wood poles.
 - c. Steel Poles:
 - 1) Poles:
 - a) Provide square, straight poles fabricated from carbon steel complying with the requirements for Grade B steel specified in ASTM A 500 and having a minimum yield strength of 46,000 pounds per square inch (317MPa).
 - (1) For poles up to 40 feet (12m) in height, provide poles having one-piece construction and an access handhole in the pole wall.
 - b) Pole Mounting Provisions:
 - (1) For bolted mounting on a foundation or breakaway support, provide a butt flange.
 - 2) Steel Mast Arms:
 - a) Provide single-arm type steel mast arms, fabricated from the same material and having the same finish as the steel pole, continuously welded to a pole attachment plate.
 - 3) Grounding and Bonding Lugs:
 - a) Provide welded 1/2-inch (13mm) threaded grounding and bonding lugs complying with requirements specified in Section 16061, Electrical Grounding and Bonding, accessible through handhole, and listed for attaching grounding and bonding conductors of the type and size specified in Section 16061.
- 5. Labels:
 - a. Provide factory-applied labels complying with the requirements specified in UL 1598.
 - 1) Locate the labels where they will be readily visible to service personnel, but will not be seen from the normal viewing angles when the lamps are in place.
 - b. Include the following lamp and ballast characteristics on the label:
 - 1) List the recommended lamps and ballasts for the luminaire.
 - a) Include the words, "USES ONLY", and the specific lamp type.
 - (1) Indicate the lamp type, wattage, and bulb type (ED17, BD56, or similar designation); and for high-intensity discharge (HID) luminaires indicate the coating (clear or coated).



- b) For high-intensity discharge (HID) luminaires, indicate the ANSI ballast type (M98, M57, or similar designation).
- 2) Indicate the correlated color temperature (CCT) and color-rendering index (CRI) for all luminaires.

G. Shop Fabrication:

1. Metal Parts:

- a. Provide metal parts that are free of burrs and sharp corners and edges.
- b. Sheet Metal Components:
 - 1) Unless otherwise indicated, provide corrosion-resistant aluminum sheet metal components.
 - 2) Form and support the sheet metal components so warping and sagging are prevented.
- c. Exposed Hardware:
 - 1) Fabricate exposed hardware from stainless steel.

H. Finishes:

1. Primer Materials:

- a. Steel Luminaires:
 - 1) For exterior surfaces, provide the manufacturer's standard primer compatible with the substrate material and the manufacturer's standard finish coats.
 - 2) For interior surfaces, provide bituminous paint.

2. Finish Materials:

- a. Steel Luminaires:
 - 1) Provide the manufacturer's standard high-gloss, high-build polyurethane enamel.
- b. Aluminum Luminaires:
 - 1) Finish designations prefixed by "AA" and specified herein or indicated on the Contract Drawings conform to the system established by the Aluminum Association for designating aluminum finishes in DAF-45.

3. Shop Finishing Methods:

- a. For recommendations for applying and designating finishes on steel luminaires, comply with the requirements specified in NAAMM AMP 500.
- b. Surface Preparation:
 - 1) Clean surfaces to remove dirt, oil, grease, and other contaminants that could impair paint bond in accordance with the requirements specified in SSPC-SP 1.
 - a) Grind welds, and polish surfaces, to obtain a smooth, even finish.
 - b) If mill scale and rust are present on uncoated steel, remove the mill scale and rust in accordance with the requirements specified in SSPC-SP 5/NACE No. 1, or SSPC-SP 8.



- c. Steel Luminaires:
 - 1) After fabricating the steel luminaires, hot-dip galvanize the luminaires in accordance with the requirements specified in ASTM A 123/A 123M.
 - 2) Apply the manufacturer's standard paint to factory-assembled and factory-tested luminaires before shipping them to the Site.
 - a) Where indicated in the Contract Documents, match the finish process and color to those of the pole or support materials.
 - 3) For the interior surfaces of the steel luminaires, apply bituminous paint or otherwise treat the interior surfaces to provide corrosion protection equal to that provided by the bituminous paint.
 - 4) For the exterior surfaces of the steel luminaires, apply the manufacturer's standard finish consisting of one or more coats of primer and two finish coats of the color selected by the Program/Project Manager from the manufacturer's standard catalog of colors.
- d. Aluminum Luminaires:
 - 1) For aluminum luminaires that are not to be field painted and not required to match finish of pole or support materials, provide one of the following finishes:
 - a) Natural Satin Finish:
 - (1) Provide a fine, directional, medium satin polish complying with the requirements for finish AA-M32 specified in DAF-45
 - (2) Buff the finish in accordance with the requirements of AA-M20 specified in DAF-45, and seal the aluminum surfaces with clear, hard-coat wax.
 - b) Class I, Clear Anodic Finish:
 - (1) Provide an AA-M32C22A41 finish (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I) complying with the requirements specified in DAF-45.
 - (2) Apply a clear coating, 0.018mm thick or thicker, complying with the requirements specified in AAMA 611.
 - c) Class I, Color Anodic Finish:
 - (1) Provide an AA-M32C22A42/A44 finish (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I) complying with the requirements specified in DAF-45.
 - (2) Provide either an integrally colored finish or electrolytically deposit a color coating 0.018mm thick or thicker and complying with the requirements specified in AAMA 611.
 - (3) Color:
 - (a) Provide a dark bronze color finish.



2.02 ACCESSORIES

- A. Concrete:
 - 1. Provide concrete materials complying with the requirements specified in Section 03300, Cast-in-Place Concrete.
- B. Concrete Formwork:
 - 1. Provide concrete formwork materials complying with the requirements specified in Section 03100, Concrete Forms and Accessories.
- C. Concrete Reinforcement:
 - 1. Provide concrete reinforcement materials complying with the requirements specified in Section 03200, Concrete Reinforcement.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine the areas to receive exterior lighting and the conditions there for compliance with requirements.
- B. Evaluation and Assessment:
 - 1. Proceed to install the exterior lighting only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect adjacent areas from damage resulting from installation of the exterior lighting.
- B. Surface Preparation:
 - 1. Concrete Pole Foundations:
 - a. Provide and finish cast-in-place pole foundations having anchor bolts matching the pole-base flange.
 - 1) Construct the concrete pole foundation formwork in accordance with the requirements specified in Section 03100, Concrete Forms and Accessories.
 - 2) Construct the concrete pole foundation concrete reinforcement in accordance with the requirements specified in Section 03200, Concrete Reinforcement.
 - 3) Construct the concrete pole foundation cast-in-place concrete in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete.
 - 4) Set anchor bolts according to anchor-bolt templates furnished by the light pole manufacturer.



3.03 INSTALLATION

A. Light Poles:

1. Align light pole foundations and light poles to obtain the optimum directional alignment of the luminaires and their mounting provisions on the pole.
2. Raise and set the light poles using web fabric slings, not chain or cable.
3. Foundation-Mounted Light Poles:
 - a. Mount the light pole on the foundation using leveling nuts, and tighten the top nuts to the torque level recommended by pole manufacturer.
 - b. Use anchor bolts and nuts selected to resist the seismic forces defined for the application, and approved by manufacturer.
 - c. Grout the void between the pole base and foundation in accordance with the requirements specified in Section 03600, Grouts.
 - 1) Provide nonshrink or expanding concrete grout firmly packed to fill the space.
 - 2) To drain condensation from the interior of light pole, provide a short piece of 1/2-inch (13mm) diameter pipe to create a drain hole through grout.
 - d. Unless otherwise indicated, install base covers.
4. Light Poles and Light Pole Foundations in Concrete Paved Areas:
 - a. Install light poles with at least a 6-inch (150mm) wide, unpaved gap between the light pole or light pole foundation and the edge of the adjacent concrete slab.
 - b. Fill the unpaved ring with pea gravel to a level 1 inch (25mm) below the top of the concrete slab.

B. Luminaires:

1. Install lamps in each luminaire.
2. Fasten the luminaires to their structural supports.
 - a. Select fastening methods and materials approved by the manufacturer to resist the seismic forces defined for the application.
 - b. Luminaire Pole Attachments:
 - 1) Mount the luminaires on the light poles in accordance with the luminaire manufacturer's installation recommendations and instructions.
 - a) Submit the luminaire manufacturer's light pole installation recommendations and instructions to the Program/Project Manager for information.

C. Bollard Luminaires:

1. Align bollard luminaire units to furnish the optimum directional alignment of light distribution.
2. Install bollard luminaire units on a concrete base having its top flush with the finished grade or the surface at the bollard's location.



- a. Cast conduit into the concrete base, and shape the base to match the shape of the bollard base.
 - b. Finish the concrete by troweling and rubbing it smooth.
- D. Ground-Mounted Luminaires:
 - 1. Install ground-mounted luminaires on concrete bases with the top 4 inches (100mm) above the finished grade or the surface at the luminaire's location.
 - a. Cast conduit into the concrete base, and finish the concrete by troweling and rubbing smooth.
- E. Electrical Grounding:
 - 1. Ground metal poles and support structures in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 - a. Install the grounding conductor pigtail for connecting the luminaire to the grounding system in the base.
 - 2. Ground nonmetallic poles and support structures in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 - a. Provide a grounding electrode for each pole.
 - b. Provide a grounding conductor and conductor protector.
 - c. Ground metallic components of the pole accessories and foundations.
- F. Special Techniques:
 - 1. Corrosion Prevention:
 - a. Do not place aluminum in contact with the earth or concrete.
 - 1) When aluminum is in direct contact with a dissimilar metal, protect the aluminum by providing insulating fittings or another treatment.
 - b. Provide steel conduits in accordance with the requirements specified in Section 16130, Raceways and Boxes
 - 1) In concrete foundations, wrap steel conduit with 0.010-inch (0.254mm) thick pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when exterior lighting is being installed, the Testing and Inspection Agency and the code-required Approved Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency and code-required Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.



- 1) Periodic Special Inspections will be performed during the installation of exterior lighting.
 - b. The Testing and Inspection Agency and the code-required Approved Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency and/or the code-required Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Illumination Tests:
 - a. Test Procedure:
 - 1) Light intensities will be measured at night using photometers having calibration referenced to National Institute of Standards and Technology (NIST) standards.
 - 2) Test measurements will be taken in accordance with the methods specified in the following Illuminating Engineering Society of North America (IESNA) testing guides as applicable:
 - a) IESNA LM-5 for photometric measurements of area lighting installations.
 - b) IESNA LM-50 for photometric measurements of roadway lighting installations.
 - c) IESNA LM-52 for photometric measurements of roadway sign installations.
 - d) IESNA LM-64 for photometric measurements of parking areas.
 - e) IESNA LM-72 for directional positioning of photometric data.
 - 3) A written report of the tests, inspections, observations, and verifications that indicates and interprets results will be prepared.
 - b. Acceptance Criteria:
 - 1) Luminaires having measurements complying with the requirements in the Contract Documents and referenced standards pass the Illumination Tests.
3. Inspections:
 - a. Inspect each installed fixture for damage.

B. Non-Conforming Work

1. Replace damaged fixtures and components.

3.05 SYSTEM STARTUP

A. Illumination Observations:



1. After installing the luminaires and energizing the electrical circuits with normal power source, verify normal operation of the lighting units.
 - a. Verify the operation of photoelectric controls.

3.06 ADJUSTING

- A. Adjust luminaires that require field adjustment or aiming.
 1. Adjust photoelectric devices to prevent false operation of the relay by artificial light sources, favoring a north orientation.
- B. If adjustments are made to the lighting system, retest the adjusted units as specified herein to demonstrate the adjusted units comply with the specified standards.

3.07 CLEANING

- A. Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Training:
 1. Train the Owner's maintenance personnel to adjust, operate, and maintain the luminaire lowering devices in accordance with the requirements specified in Section 01770, Closeout Procedures.

3.09 PROTECTION

- A. Take steps to ensure that installed exterior lighting units are protected during subsequent construction activities.

3.10 MAINTENANCE

- A. Operation and Maintenance Data:
 1. Furnish operation and maintenance data for exterior luminaires and light poles for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. Provide a list of all lamp types used on the Contract using ANSI and manufacturers' codes to identify each.
 2. Submit the operation and maintenance data for exterior luminaires and light poles to the Program/Project Manager for information.

END OF SECTION



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1K.02.A.5, 1.02.C.18, 2.10.B.2	Add requirements for ENVISION Sustainability Rating System



SECTION 16527

LANDSCAPE LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for in-grade uplights with luminaires, including lamps, power modules, and hardware.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01780 - Closeout Submittals.
 - 4. Section 03100 - Concrete Forms and Accessories.
 - 5. Section 03300 - Cast-In-Place Concrete.
 - 6. Section 16061 - Electrical Grounding and Bonding.
 - 7. Section 16120 - Conductors and Cables.
 - 8. Section 16130 - Raceway and Boxes.
 - 9. Section 16140 - Wiring Devices.
 - 10. Section 16145 - Lighting Control Devices.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CCT: Correlated color temperature.
 - 2. CRI: Color-rendering index.
 - 3. LED: Light emitting diode.
 - 4. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.
 - 5. NPT: National pipe thread tapered thread.
 - 6. PVC: Polyvinyl-chloride.
 - 7. UV: Ultraviolet.
 - 8. ENVISION: The rating system for sustainable infrastructure as published by the Institute for Sustainable Infrastructure
- B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.
2. Luminaire: The complete lighting fixture, including the power module housing if provided.

C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI/ANSI C78.390 - American National Standard for Electric Lamps—Method of Designation for Electric Lamps-Miniature and Sealed Beam Incandescent Lamps.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ANSI/ASHRAE/IESNA 90.1-2007 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. ANSI/IEEE C2– National Electrical Safety Code® (NESC).
4. International Electrotechnical Commission (IEC):
 - a. IEC 60529 - Degrees of protection provided by enclosures (IP Code).
5. National Electrical Manufacturers Association (NEMA):
 - a. NEMA SSL 3 – High-Power White LED Binning for General Illumination.
6. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code® (NEC).
7. National Institute of Standards and Technology (NIST):
 - a. Standards Services Division,
<http://ts.nist.gov/standards/accreditation/index.cfm>:
 - 1) NIST Handbook 150 – National Voluntary Laboratory Accreditation Program Procedures and General Requirements.
 - 2) NIST Handbook 150 Checklist.
 - 3) NIST Handbook 150-1 – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products.
 - 4) NIST Handbook 150-1 Checklist.
 - 5) NIST Handbook 150-1A – National Voluntary Laboratory Accreditation Program Energy Efficient Lighting Products – Solid State Lighting.
 - 6) NIST Handbook 150-1A Checklist.
8. Underwriters Laboratories, Inc. (UL):
 - a. UL 1598 – Luminaires.
 - b. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.
9. Institute for Sustainability Infrastructure (ISI):
 - a. ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.
10. Institute for Sustainable Infrastructure (ISI) ENVISION Rating System for Sustainable Infrastructure 2015



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the location of the electrical conduit and pullboxes provided under another contract for the landscape lighting luminaires being provided under this Section with the other contractor.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Luminaires.
 - b. Shop Drawings:
 - 1) Luminaires.
 - c. Qualification Statements:
 - 1) Landscape lighting installer's qualifications.
 - 2) Evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Landscape lighting manufacturer's published installation instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and maintenance data for the landscape lighting.

D. Maintenance Material Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Furnish spare exterior lighting products that match the products installed, and packaged for storage by having a protective coverings and labels identifying the contents.
 - a) Lamps:



- (1) For each type and rating of lamp installed, furnish 1 spare lamp for every 100 lamps installed, but not less than one of each type and rating.
- b) Lenses, Covers, and Other Optical Parts:
 - (1) For each type and rating of glass and/or plastic lens, cover, and other optical part installed, furnish 1 spare glass and plastic lens, cover, or other optical part for every 100 glass and plastic lens, cover, or other optical part installed, but not less than one of each type and rating.
- c) Power Modules
 - (1) For each type and rating of power modules installed, furnish 1 spare power module for every 100 power modules installed, but not less than one of each type and rating.
- d) Guards:
 - (1) For each type and rating of guard installed, furnish 1 spare guard for every 20 guards installed, but not less than one of each type and rating.

1.05 QUALITY ASSURANCE

A. Qualifications:

- 1. Landscape Lighting Installer's Qualifications:
 - a. Employ qualified and experienced electricians to install the landscape lighting fixtures.
 - b. Submit the landscape lighting installer's qualifications to the Program/Project Manager for approval.
- 2. Luminaire Photometric Data Testing Laboratory Qualifications:
 - a. Procure products from manufacturers participating in the National Volunteer Laboratory Accreditation Program (NVLAP), and which have manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products – Solid State Lighting, as specified in the appropriate handbooks and checklists.
 - 1) Submit evidence that the laboratories of the manufacturers providing photometric data for lighting fixtures are accredited under the National Volunteer Laboratory Accreditation Program to the Program/Project Manager for approval.

B. Certifications:

- 1. Listing and Labeling of Electrical Components, Devices, and Accessories:
 - a. Provide products that are listed and labeled as defined in Article 100 of NFPA 70 by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), such as Underwriters Laboratories, Inc. (UL), for the location the product is installed in, and the application intended,



unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.

- 1) Provide products marked with their intended use or classification.
- 2) Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
 - a) Such evidence may consist of either a printed mark on the data or a separate listing card.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Deliver lighting fixtures in a clean, undamaged condition.
2. Inspect lighting fixtures for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.

B. Storage and Handling Requirements:

1. Handle lighting fixtures in accordance with the manufacturer's written instructions.
2. Follow the manufacturer's written instructions for storing the lighting fixtures.
3. Protect the lighting fixtures from damage during their unloading or removal, storage, and installation.
 - a. Replace broken fixtures, glassware, or other items with new parts, at no increase in Contract Price, and without undue delay or inconvenience.

C. Packaging Waste Management:

1. Dispose of packaging waste in accordance with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 LANDSCAPE LIGHTING SYSTEMS

A. Manufacturers:

1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide the product manufactured by the manufacturer listed herein.
2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed may be provided.



B. Description:

1. Regulatory Requirements:

a. National Electrical Code (NEC):

- 1) Provide products and installation complying with the requirements specified for external lighting in NFPA 70.

b. National Electrical Safety Code (NESC):

- 1) Provide products and installation complying with requirements specified for exterior lighting in ANSI/IEEE C2.

2. Sustainability Requirements:

a. Institute for Sustainable Infrastructure (ISI) "ENVISION" rating system for sustainable infrastructure requirements.

- 1) Provide landscape lighting that meet the ENVISION ratings for reduced energy consumption.
- 2) Provide landscape lighting that meet the performance requirements established in the contract documents for purposes of maintaining the as designed energy reduction in accordance with the Appendix D in ANSI/ASHRAE/IESNA 90-2007.

C. Performance:

1. Maximum Load Rating:

- a. Provide landscape lighting capable of withstanding at least a 2847-pound compressive force.

2. Light Distribution:

- a. Provide landscape lighting that has light emitting diode (LED) modules capable of at least 15 degree of internal tilt from vertical, and of 360 degrees of horizontal rotation.

D. Design Criteria:

1. Luminaires:

- a. Provide exterior luminaires complying with the requirements specified in UL 1598, and that are listed and labeled for installation in wet locations by a nationally recognized testing laboratory (NRTL), such as Underwriters Laboratories, Inc. (UL), acceptable to the Authorities Having Jurisdiction.

b. Light Source Type:

- 1) Provide landscape lighting that uses light emitting diodes (LEDs) as the source of light as indicated on the Contract Drawings.

c. Voltage:

- 1) Provide landscape lighting power modules capable of operating on a 120-Volt, 60 Hertz power source.

d. Housings:

- 1) Provide rigidly formed, weather-tight and light-tight enclosures that will not warp, sag, or deform in use; and that comply with the requirements for an IP68 rating specified in IEC 60529.

2. Product Data:



- a. Obtain Product Data for each type of luminaire including information regarding product features, accessories, and finishes including the following:
 - 1) A physical description of luminaires, including their materials, dimensions, effective projected area, and verification of the indicated parameters.
 - 2) Details for attaching accessories.
 - 3) Instruction sheets which clearly shows installation procedures, instructions for adjusting the lamp socket, and details of construction.
 - 4) Luminaire materials.
 - 5) Testing Agency Certified Data:
 - a) Photometric data certified by a qualified independent testing agency and based on laboratory testing of each luminaire type, complete with its indicated lamps, power modules, and accessories.
 - 6) Photoelectric relays.
 - 7) Power module energy-efficiency data, power module electrical data, and lamp operating volt-watt traces for nominal and 10 percent rated line voltage to verify power module performance and compliance with the lamp specifications for the rated life of the lamp.
 - 8) Lamps, including life, output, correlated color temperature (CCT), color-rendering index (CRI), lumens, and energy-efficiency data.
- b. Submit Product Data for each type of luminaire to the Program/Project Manager for approval.
- 3. Shop Drawings:
 - a. Prepare Shop Drawings showing the luminaires proposed for the Work of this Section.
 - 1) Include plans, elevations, sections, details, and attachments to other work.
 - a) Detail equipment assemblies, and indicate the dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2) Wiring Diagrams:
 - a) Furnish wiring diagrams for power, signal, and control wiring.
 - b. Submit the Shop Drawings for each luminaire and support component to the Program/Project Manager for approval.
- E. Components:
 - 1. Landscape Lighting Enclosures:
 - a. Enclosure Doors:
 - 1) Provide die cast stainless steel doors for the landscape lighting enclosures.
 - 2) Provide decorative rockguard doors to protect the lenses.
 - b. Enclosure Housings:



- 1) Provide enclosure housings that have a side-car configuration to house the lamp, power module components, and the lens/door finishing sections.
 - 2) Provide compression molded ultraviolet light stabilized polyester enclosure housings that are impact and corrosion resistant, and designed for use in all types of environments.
 - 3) Provide enclosure housings that have an internal direct access junction box with 44 inches of squared volume for through-branch wiring and to ensure a proper seal during installation.
- c. Conduit Entries:
 - 1) Provide 2 molded 3/4-inch national pipe thread tapered thread (NPT) side entries as standard, and bottom hubs having molded with a 3/4-inch national pipe thread tapered thread (NPT) membrane knockouts.
- d. Finish:
 - 1) Provide lens/door finishing sections having a natural bronze, stainless steel, or brushed stainless steel finish.
 - a) Bronze doors may be painted with a color selected by the Program/Project Manager from the manufacturer's full line.
2. Lens/Seal:
 - a. Provide lens/seal assemblies for the landscape lighting fabricated from tempered clear flat borosilicate glass and secured in place to the housing by 3 captive screws.
 - 1) Provide notched lenses designed to provide the maximum aperture opening.
 - 2) Provide a lens gasket.
3. Power Module:
 - a. Provide an integrally mounted modular light emitting diode (LED) driver that has been prewired with quick connectors to facilitate easy installation and maintenance.
4. Luminaires:
 - a. Provide light emitting diode (LED) luminaires having a brass top ring, heat sink, and reflective secondary infrared (IR) lens filter to reduce heat.
 - b. Light Emitting Diode (LED) Reflector Assembly:
 - 1) Provide rugged, high-grade light emitting diode (LED) reflector assemblies securely mounted to a support bracket.
 - c. Lamps:
 - 1) Provide 12-Watt monochromatic light emitting diode (LED) lamps rated at 360 lumens per lamp.
 - 2) Provide lamps having an average rated life of 50,000 hours.
 - 3) Provide light emitting diode (LED) lamps having a light color temperature of 4000K warm white.
 - 4) Clearly and permanently mark each lamp, giving the wattage, manufacturer's reference number, and the American National



Standards Institute (ANSI) reference number in accordance with the requirements specified in ANSI_ANSLG C78.390.

5. Power Modules:
 - a. Provide power modules rated to the circuit voltage and size of the lamps specified.
 - b. Provide power modules that reliably start and operate the lamps in ambient temperatures down to minus 40 degrees Fahrenheit for the rated life of the lamp.
 - c. For nominal line voltage and nominal lamp voltage, provide power modules having design centers that do not vary more than 2 percent from the rated lamp wattage.
 - d. Provide power modules having a lamp wattage regulation spread that does not exceed 2 percent for 10 percent line voltage variation at any lamp voltage from nominal through life.
 - e. Provide lamp- power module systems designed so the power factor does not drop below 90 percent for 10 percent life.
 - f. Provide power modules that protect themselves against normal lamp failure modes.
 - g. Provide power modules that are capable of operation with the lamp in an open or short-circuit condition for 6 months without significant loss of power module life.
 - h. Provide power modules that make their electrical connections through pre-wired quick disconnect plugs.
6. Manufacturers:
 - a. Acuity Brands Lighting, Inc., Hydrel Paradox™ Architectural In-Grade Luminaire, Catalog Number PDX7-SS-12LED-WHT30K-MVOLT-SP-FLC-34S-RG-LPI, <http://www.acuitybrands.com>.
 - b. Approved equal.

2.02 ACCESSORIES

- A. Concrete:
 1. Provide Class B concrete complying with the requirements specified in Section 03300, Cast-In-Place Concrete.
- B. Concrete Formwork:
 1. Provide concrete formwork materials complying with the requirements specified in Section 03100, Concrete Forms and Accessories.
- C. Conduit:
 1. Provide polyvinyl-chloride (PVC) conduit complying with the requirements specified in Section 16130, Raceway and Boxes.
- D. Electrical Wiring:



1. Provide electrical wiring complying with the requirements specified in Section 16120, Conductors and Cables.
- E. Electrical Switches and Controls:
 1. Provide electrical switches and controls complying with the requirements specified in Section 16140, Wiring Devices, and Section 16145, Lighting Control Devices.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine the areas to receive landscape lighting and the conditions there for compliance with requirements.
 2. Verify that the electrical power conduit and pull boxes that have been provided under another contract for the light fixture and wiring Work of this Section are properly in place.
- B. Evaluation and Assessment:
 1. Proceed to install the landscape lighting only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
 1. Protect adjacent areas from damage resulting from installation of the landscape lighting.
- B. Surface Preparation:
 1. For each luminaire and its "rough-in-section", excavate a hole to the approximate depth that allows conduit to be roughed-in and secured to the luminaire.
 - a. Before installing the conduit to the luminaire, apply suitable thread sealing compound to the conduit threads to ensure the conduit is watertight and to prevent moisture from penetrating the conduit system.
 2. If the luminaires are being installed in organic mulch, surround the "rough-in-section" with approximately 6 inches of sand or another non-organic substance.

3.03 INSTALLATION

- A. Luminaires:
 1. Construct the landscape lighting in accordance with the manufacturer's installation instructions and the details shown on the Contract Drawings.



- a. Submit the landscape lighting manufacturer's published installation instructions to the Program/Project Manager for information.
 2. Install lamps in each luminaire.
- B. Collars:
 1. Provide and finish cast-in-place concrete collars as detailed on the Contract Drawings.
 - a. Construct the collar concrete formwork in accordance with the requirements specified in Section 03100, Concrete Forms and Accessories.
 - b. Construct the collar cast-in-place concrete in accordance with the requirements specified in Section 03300, Cast-In-Place Concrete.
- C. Systems Integration:
 1. Ground the landscape lighting fixtures in accordance with the requirements specified in Section 16061, Electrical Grounding and Bonding.
 2. Connect wiring to the landscape lighting fixtures in accordance with the requirements specified in Section 16120, Conductors and Cables.
 3. Install lighting switches and controls in accordance with the requirements specified in Section 16140, Wiring Devices, and Section 16145, Lighting Control Devices.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 1. Inspections:
 - a. Upon completion of the installation of the landscape lighting fixtures and lighting equipment, verify that they are in first-class operating order and their finish and other associated items are in perfect condition.
 - b. Check for the proper operation and appearance of the landscape lighting, the alignment of the fixtures, and the proper placement of lenses, louvers, lamps, and other light-controlling or modifying appurtenances.
- B. Non-Conforming Work
 1. Correct or replace non-conforming Work.

3.05 ADJUSTING

- A. Adjust angles of tilt and rotation of the lamps to aim the beams where indicated in the Contract Drawings.



3.06 CLEANING

- A. Immediately prior to the final inspection, damp clean the landscape lighting glassware, fixture trims, and reflectors.
- B. Clean the lamps, or install new lamps, as directed by the Program/Project Manager.
 - 1. Insure that the glass and fixtures are free of labels.
- C. Waste Management:
 - 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 PROTECTION

- A. Take steps to insure that installed landscape lighting units are protected during subsequent construction activities.

3.08 MAINTENANCE

- A. Operation and Maintenance Data:
 - 1. Furnish operation and maintenance data for landscape lighting for inclusion in emergency and operation and maintenance manuals as specified in Section 01780, Closeout Submittals, and include the following:
 - a. Provide a list of the lamp types used for landscape lighting using ANSI and manufacturers' codes to identify each.
 - 2. Submit the operation and maintenance data for the landscape lighting to the Program/Project Manager for information.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.



SECTION 16702

BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic requirements for providing additions to the Premises Distribution System (PDS), including a Structured Cabling System (SCS), at the Phoenix Sky Harbor International Airport as specified and shown on the Contract Drawings.
2. Procedural requirements for maintaining documents and Samples at the Site.
3. Requirements for relocation and modifications of the Premises Distribution System (PDS), including a Structured Cabling System (SCS), at the Phoenix Sky Harbor International Airport as specified and shown on the Contract Drawings.

B. Related Requirements:

1. Section 01330 - Submittal Procedures.
2. Section 01780 - Closeout Submittals.
3. Section 16061 – Communications Grounding and Bonding.
4. Section 16076 – Communications Identification.
5. Section 16081 – Communications Testing.
6. Section 16705 – Pathways for Communications Services.
7. Section 16711 – Communications Equipment Room Fittings.

1.02 REFERENCES

A. Abbreviations and Acronyms:

1. CAD: Computer-aided design.
2. FVP: ITS Field Verification Partner.
3. IDF: Intermediate Distribution Frame.
4. ITS: Information Technology System.
5. MDF: Main Distribution Frame.
6. NEC: National Electrical Code.
7. PDS: Premises Distribution System.
8. PSHIA: Phoenix Sky Harbor International Airport.
9. RCDD: Registered Communications Distribution Designer.
10. SCS: Structured Cabling System.
11. TGB: Telecommunications grounding busbar.
12. TSB: Technical Systems Bulletin.

B. Definitions:



1. Authority Having Jurisdiction (AHJ): Building Code officials, zoning officials, inspectors, and government and regulatory agencies given the authority to protect the public's health, safety, and welfare.

C. Reference Standards:

1. American National Standards Institute (ANSI):
 - a. ANSI/J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
2. Building Industry Consulting Services International (BICSI):
 - a. BICSI TDMM - Telecommunications Distribution Methods Manual.
 - b. BICSI OSPDRM – Outside Plant Design Manual.
3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department:
 - 1) Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
4. InterNational Committee for Information Technology Standards (INCITS):
 - a. ANSI/INCITS 231 – Information Systems – Fibre Distributed Data Interface (FDDI) – Physical Layer Protocol (PHY-2).
5. International Standards Organization/International Electrotechnical Commission (ISO/IEC):
 - a. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premises.
6. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
7. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
8. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - b. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA-568-B.3 – Optical Fiber Cabling Components Standard.
 - d. ANSI/TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure.
 - e. ANSI/TIA/EIA-758-A – Customer Owned Outside Plant Telecommunications Infrastructure Standard.
9. Telecommunications Industry Association (TIA):
 - a. TIA-569-B – Commercial Building Standard for Telecommunications Pathways.



- b. TSB-140 – Additional Guidelines for Field Test Length, Loss and Polarity of Optical Fibers.
- 10. Underwriters Laboratories, Inc. (UL):
 - a. UL Performance Verification Service Requirements.
 - b. UL Qualification Tests and Follow-Up Service Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate all communications work with the Program/Project Manager and the approved Contract schedule.
 - a. Adhere to the approved installation schedule.
 - b. Give required notices for items affecting the Contract schedule.
 - 2. Coordinate delivery of extra materials, spare parts, and maintenance materials for the Structured Cabling System (SCS) to the Site with the Program/Project Manager, and obtain receipts for these materials prior to requesting final payment.
 - 3. Provide the final coordination and field routing required for completing the communications infrastructure at the Phoenix Sky Harbor International Airport as indicated in the Contract Documents.
- B. Pre-Installation Meetings:
 - 1. Coordinate construction meetings with the Program/Project Manager.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Certificates:
 - 1) Structured Cabling System Certification.
 - b. Qualification Statements:
 - 1) Structured Cabling System manufacturers' qualifications.
 - 2) Resumes for each member of the Structured Cabling System installation team.
 - 3) Communications project references.
- B. Informational Submittals:
 - 1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Sustainable Design Submittals:
 - 1) Approval documents from the regulatory agencies.
- C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) Communications system record documents and Samples.
- D. Maintenance Material Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Spare Parts:
 - 1) Provide spare parts and maintenance materials in quantities as specified in each Section, in addition to those used for construction of the Work.
 - b. Extra Stock Materials:
 - 1) Provide extra materials in quantities as specified in each Section, in addition to those used for construction of the Work.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Submit the documents required by State Licensure inspectors and other Authorities Having Jurisdiction to the appropriate agencies.
 - a. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of the communications Work as applicable for this Contract.
 - b. Submit the approval documents from the regulatory agencies to the Program/Project Manager for information.
- B. Qualifications:
 1. Structured Cabling System Manufacturer's Qualifications:
 - a. Provide components for the Structured Cabling System that have been produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed under this Contract for a minimum of 5 years.
 - b. Submit the Structured Cabling System manufacturer's qualifications to the Program/Project Manager for approval.
 2. Structured Cabling System Installer's Qualifications:
 - a. Because the Structured Cabling System (SCS) to be installed at the Phoenix Sky Harbor International Airport is required to be a complete end to end (channel) solution, a single entity must take responsibility for certifying and warranting all components of the system including backbone cabling, horizontal cabling, outside plant cabling, and all termination devices.



- b. Employ a manufacturer-certified Structured Cabling System Installer to install, certify, and warranty the entire specified Structured Cabling System.
 - 1) All members of the Structured Cabling System installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation.
 - 2) Submit a resume for each member of the Structured Cabling System installation team, including documentation of completed training courses, to the Program/Project Manager for approval.
 - c. Registered Communications Distribution Designer (RCDD):
 - 1) The Structured Cabling System Installer must furnish an onsite BICSI Registered Communications Distribution Designer (RCDD) to supervise the communications system Work performed under this Contract, and who demonstrates knowledge of the Codes, Standards, and UL service requirements listed in Paragraph 1.02.C and in the Division 16 Sections listed in Paragraph 1.02.B.
 - d. Communications Project References:
 - 1) Submit 5 references for communications projects completed by the Structured Cabling System Installer within the last 5 years of an equivalent scope, type, and complexity of work to the Work required under this Contract to the Program/Project Manager for approval.
- C. Certifications:
- 1. Structured Cabling System Certification:
 - a. Submit the manufacturer-certified Structured Cabling System Installer's Structured Cabling System Certification certifying the Structured Cabling System has been installed in accordance with the requirements of the Contract Documents and functions as a complete end to end (channel) communications system to the Program/Project Manager.

1.06 SITE CONDITIONS

- A. Existing Conditions:
 - 1. Premises Distribution System (PDS):
 - a. A Premises Distribution System (PDS) consisting of an active and passive infrastructure has been implemented at Phoenix Sky-Harbor International Airport.
 - 1) This infrastructure provides the backbone and interconnections to various computer and telephone systems throughout the airport.
 - 2) Installation of the infrastructure devices follows an industry recognized standards-based approach.
 - b. An approved common wiring scheme for all organizations within the facility, critical to support the services and equipment from multiple vendors, has been established.



- 1) Standards have been established to define the cabling types and their maximum distances, communications room design aspects, work area and component recommendations, and the means of connecting to various application systems.
- c. Additions to this Premises Distribution System (PDS) must comply with the established standards and be properly coordinated.

PART 2 PRODUCTS

2.01 PREMISES DISTRIBUTION SYSTEM (PDS)

- A. Manufacturers:
 1. Manufacturer List:
 - a. Automation Direct, <https://www.automationdirect.com/>.
 - b. Approved equal.
 2. Substitution Limitations:
 - a. Substitutions for any product identified in the Contract Drawings or Specifications must be submitted to and approved by the Program/Project Manager prior to being incorporated into the Work.
 - 1) Thoroughly investigate the proposed product and determine that it is equal to or superior in all respects to the specified product, and whether license fees and royalties are pending on the proposed substitute.
 - 2) Provide the same type of written warranty for the substitution as for the specified product, guaranteeing the substituted products have the same or superior performance as the product specified.
 - 3) Coordinate the installation of approved substitutes, making such changes as may be required for the Work to be complete in all respects, and at no increase in Contract Price unless otherwise agreed to in writing by the Owner as provided for in the Agreement.
 - b. Submittals that include requests for substitutions of products will be accepted no later than 90 calendar days after the Notice to Proceed for this Contract has been given to the Contractor.
 - c. Requests for Substitution:
 - 1) Submit Requests for Substitution complete with data substantiating compliance of the proposed substitution with the requirements of Contract Documents, and must include the following information at a minimum:
 - a) Project title and the Owner's project number.
 - b) Identification of the product specified, including its Specifications Section and Paragraph numbers.
 - c) Identification of the proposed substitute complete with the manufacturer's name and address, the trade name of the product, and the model or catalog number.



- d) Names, addresses, and phone numbers of the proposed substitution's fabricator(s) and Supplier(s).
 - e) The effect of the substitution on the dimensions, material thicknesses, wiring, piping, ductwork, and similar items indicated in the Contract Documents.
 - f) The effect of the substitution on other trades.
 - g) The effect of the substitution on the construction schedule.
 - h) Differences in quality and performance between the specified product and the proposed substitute.
 - i) Availability of maintenance services and replacement materials for the proposed substitute.
 - j) License fees and/or royalties pending on the proposed substitute.
3. Product Options:
- a. Submit documentation for the components proposed to be installed under this Contract as required in the individual Specification Sections.
 - 1) The City of Phoenix reserves the right, at the sole discretion of the Program/Project Manager, to request submittal documentation for any component of the system the Program/Project Manager deems necessary to ensure compliance to the Contract Drawings and Specifications.
 - 2) Provide submittals for specific components to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures, prior to installing the component.

B. Description:

- 1. The Premises Distribution System (PDS), including the Structured Cabling System (SCS), to be installed at the Phoenix Sky Harbor International Airport is required to be a complete end to end (channel) solution.
 - a. Provide the materials described and shown on the Contract Drawings.
 - b. Provide all cabling, including patch cords, connectors, adapters, and terminations necessary to interconnect all system equipment, including equipment located in the Communications Rooms (MDFs/IDFs), and as shown on the Contract Drawings.
- 2. Regulatory Requirements:
 - a. Comply with the codes, ordinances, regulations, and other legal requirements of public authorities which apply to the performance of the communications Work of this and the other Division 16 Sections referenced in Paragraph 1.01.B, including among others the following:
 - 1) Phoenix Building Construction Code and Amendments.
 - 2) City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - 3) Aviation Supplement to City of Phoenix Information Technology Standards.



C. Performance:

1. Provide a complete and operational end to end (channel) Premises Distribution System (PDS), including the Structured Cabling System (SCS), at the Phoenix Sky Harbor International Airport complying with the requirements indicated in the Contract Documents.

D. Design Criteria:

1. Design the Premises Distribution System (PDS), including the Structured Cabling System (SCS), in accordance with the requirements specified in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, ANSI/TIA/EIA-568-B.3, and the BICSI Telecommunications Distribution Methods Manual which have been established by the Phoenix Sky Harbor International Airport as the standards for cabling infrastructure installations.
 - a. These requirements are defined in the Phoenix Sky Harbor International Airport (PSHIA) Premises Distribution System (PDS) Standards:
 - 1) City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
2. The publications listed in the "Reference Standards" Paragraphs in the Division 16 Sections listed in Paragraph 1.01.B of this Section are incorporated into this Contract to the extent they are referenced.
 - a. The publications are referred to in the text by basic designation only.
 - b. Whenever conflicts between referenced requirements occur, comply with the one establishing the more stringent requirements.
 - c. Whenever conflicts between referenced requirements and the Contract Documents occur, comply with the one establishing the more stringent requirements.
3. Perform the calculations and analyses to support design decisions.
4. Contract Record Documents and Samples:
 - a. Prepare Contract record documents that are in compliance with the City of Phoenix Aviation Department's standards:
 - 1) Prepare Contract record drawings prepared using AutoCAD 2006, or City's latest version of CAD software.
 - 2) Prepare Contract record text documents using Microsoft Word 2003 and Excel 2003, or the City's latest versions of word processing and spreadsheet software.
 - b. Store and maintain the Contract records documents and Samples apart from the documents used for construction in the field office at the Site.
 - 1) Provide files, racks, and secure storage for the Records Documents and Samples.
 - 2) Maintain record documents in clean, dry, legible condition.
 - 3) Do not use record documents for construction purposes.



- 4) Record as-built information concurrently with construction progress.
 - a) Legibly mark a copy of the Project Manual and the Contract Drawings to record actual construction, including the following:
 - (1) On appropriate pages, record changes made by Addenda, Change Orders and other modifications.
 - (2) On appropriate pages, enter trade name, manufacturer, catalog number, and name of supplier of each product and item actually installed, if different from that specified.
 - (3) Other items installed but not originally specified.
 - b) Do not conceal the Work until the required information has been recorded.
 - c. Contract Record Documents and Samples include, but are not limited to, the following:
 - 1) Contract Drawings showing the systems' components.
 - 2) Specifications and Schedules (Project Manual).
 - 3) Addenda.
 - 4) Change Orders and other documents which modify original document.
 - 5) Approved Shop Drawings, Product Data, and Samples.
 - 6) Samples.
 - 7) Manufacturer's certificates.
 - 8) Fixed Equipment Manuals
 - 9) As-built record documents recording all changes made during the construction, and including systems' components, cable records, drawings, and cable management information, that have been approved by the Program/Project Manager.
 - 10) Field Inspection Certificates indicating components have been installed correctly with written acceptance by the Program/Project Manager's field inspector(s).
 - 11) Cable and field test records.
- E. Materials:
1. Plywood:
 - a. Provide void free A-C fire rated plywood.
 2. Paint:
 - a. Provide fire retardant paint.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Verify that liquid-carrying pipes are not installed in or above voice and data system equipment rooms.



- a. If liquid-carrying pipes are identified, do not install communications equipment without written approval from the Program/Project Manager.
2. Verify support devices for communications equipment are properly installed.

3.02 INSTALLATION

A. Backboards:

1. Properly install plywood backboards for mounting telecommunications equipment in each Communications Room (MDF/IDF).
 - a. Cover each wall of the Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) with rigidly fixed 3/4-inch void free A-C fire rated plywood, 8 feet high, and capable of supporting attached equipment.
 - 1) Coat the plywood with a minimum of 2 coats of fire retardant white paint.
 - 2) Do not paint over the fire rated label, but ensure it remains visible once the plywood is installed.

B. Interface with Other Work:

1. Power for Technology Equipment:
 - a. In each telecommunications room, provide a minimum of 2 electrical outlets fed from single fused 120 Volt 20 Amp circuits in dedicated panels located within the communications room and served from an emergency backup power system to ensure continuous uninterrupted power to the technology equipment.
 - 1) Clearly mark the circuits as dedicated for technology.
2. In telecommunication rooms, provide open, hard lid ceilings having a minimum height of 8'-6" to avoid dust.
3. Do not locate telecommunications rooms, Main Distribution Frame's (MDF), and Intermediate Distribution Frame's (IDF) adjacent to any spaces that contain sources of Electromagnetic Interference (EMI).
4. Provide anti-static flooring in telecommunication rooms.
5. Locate transformers at least 4 feet from any communications cable or termination equipment.
6. Do not locate transformers in telecommunications closets.

C. Systems Integration:

1. Install the components of the Structured Cabling System (SCS) in accordance with the Building Industry Consulting Services International (BICSI) recommended practices in BICSI TDM and BICSI OSPDRM; and with ANSI/J-STD-607-A, ANSI/INCITS 231, ISO/IEC 11801, NFPA 70, ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, ANSI/TIA/EIA-568-B.3, ANSI/TIA/EIA-606-A, ANSI/TIA/EIA-758-A,



TIA-569-B, TSB-140, the PSHIA Premises Distribution System Standards, and the Division 16 Sections listed in Paragraph 1.01.B.

2. Bond and ground protected telecommunication terminations to a telecommunications grounding busbar (TGB) as specified in Section 16061, Communications Grounding and Bonding.

3.03 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. Site Tests:

- a. During the period when the Premises Distribution System (PDS), including the Structured Cabling System (SCS), is being installed, the Testing and Inspection Agency is required to perform routine and other testing of systems and materials.

- 1) Advise the Program/Project Manager and Testing and Inspection Agency at least 1 week prior to the expected time of operations requiring the inspection and testing services in order to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.

- a) If, after such notice, tests or inspections cannot be performed as scheduled, notify the Program/Project Manager.
- b) Cooperate with laboratory personnel and the Program/Project Manager, and provide access to the Work.
- c) Provide incidental labor and facilities to provide access to the Work to be tested, to facilitate tests and inspections, and for storage of test equipment.

- 2) After each inspection and/or test, the Program/Project Manager will send 2 copies of a field verification report signed by persons authorized to sign for the Testing and Inspection Agency which conducted the tests to the project management team, and 2 copies to the Contractor, that each include the following information:

- a) Date issued.
- b) Contract title and number.
- c) Contract phase of testing.
- d) ITS Field Verification Partner (FVP) name, address, and telephone number.
- e) Name of inspector and job number.
- f) Date and time of sampling inspection.
- g) Record of temperature and weather conditions.
- h) Date of Test.
- i) Specification Section identification.
- j) Location of test.
- k) Cable identification, if applicable.
- l) Type of inspection or test.
- m) Results of test, and compliance with Contract Documents.



- n) Interpretation of test results.
- 3) The Testing and Inspection Agency will perform additional systems and materials testing due to changes in the system requested by the Contractor or testing required due to failure of systems to meet specified requirements.
- 4) Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
- 2. Inspections:
 - a. Verify that conduit, raceways, boxes, handholds and manholes to be utilized have been properly installed in accordance with the applicable BICSI and ANSI/TIA/EIA standards and recommendations specified in Section 16705, Pathways for Communications Services.
 - 1) Verify that conduit is a minimum of 1 inch in diameter.
 - b. Verify that the telecommunications grounding system has been properly installed and tested in accordance with the BICSI and ANSI/TIA/EIA standards and recommendations specified in Section 16061, Communications Grounding and Bonding.
- B. Non-Conforming Work
 - 1. If items are verified to be non-compliant with the requirements stated in this Section, or with the BICSI and ANSI/TIA/EIA standards and recommendations, cease all work and notify the Program/Project Manager immediately.

3.04 SYSTEM STARTUP

- A. After installing and testing the completed system, have the manufacturer-certified Structured Cabling System Installer provide a Structured Cabling System Certification certifying the Structured Cabling System has been installed in accordance with the requirements of the Contract Documents and functions as a complete end to end (channel) communications system.

3.05 CLOSEOUT ACTIVITIES

- A. Training:
 - 1. Provide training by the manufacturer of the installed Structured Cabling System for up to 5 City of Phoenix Aviation Department employees, or other designees, named by the Program/Project Manager.
 - a. Provide these employee trainees with the skills to manage, troubleshoot, and perform moves, additions, and changes to the installed Structured Cabling System (SCS) under the specific manufacturer warranty requirements.



B. Contract Record Documents and Samples:

1. Prior to Contract Closeout, submit the communications system record documents and Samples, to Program/Project Manager under cover of a transmittal letter containing the following:
 - a. Date.
 - b. Contract title and number
 - c. Contractor's and his Subcontractor's names and addresses.
 - d. Title and number of each record document.
 - e. Certification that each document submitted is complete and accurate.
 - f. Signature of the Contractor or his authorized representative.
2. Submit the Contract Records Documents in Unifier, and physically deliver Samples, to the Program/Project Manager.

END OF SECTION

Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16705

PATHWAYS FOR COMMUNICATION SERVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing interior communications pathways.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 02582 – Underground Ducts and Manholes.
 - 4. Section 07850 - Through Penetration Firestopping Systems.
 - 5. Section 16061 - Communications Grounding and Bonding.
 - 6. Section 16070 - Hangers and Supports.
 - 7. Section 16076 - Communications Identification.
 - 8. Section 16081 - Communications Testing.
 - 9. Section 16702 - Basic Communications Materials and Methods.
 - 10. Section 16711 - Communications Equipment Room Fittings.
 - 11. Section 16712 - Communications Backbone Cabling.
 - 12. Section 16713 - Communications Horizontal Cabling.
 - 13. Section 16714 - Communications Connecting Cords, Devices, and Adaptors.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. HVAC: Heating, ventilation, and air conditioning.
 - 2. IDF: Intermediate Distribution Frame.
 - 3. MDF: Main Distribution Frame.
 - 4. NEC: National Electrical Code.
 - 5. PVC: Polyvinyl chloride.
 - 6. TGB: Telecommunications grounding busbar.
- B. Reference Standards:
 - 1. American National Standards Institute (ANSI):
 - a. ANSI C80.3 - Electrical Metallic Conduit – Zinc Coated (EMT).
 - b. ANSI/ASA Color Charts.
 - 2. ASTM International (ASTM):
 - a. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.



- c. ASTM B 26/B 26M - Standard Specification for Aluminum-Alloy Sand Castings.
 - d. ASTM E 84 - Standard Test Method for-Surface Burning Characteristics of Building Materials.
 - e. ASTM E 119 - Standard Test Methods for-Fire Tests of Building Construction and Materials.
 - f. ASTM E 814 - Standard Test Method for-Fire Tests of Through-Penetration Fire Stops.
- 3. Building Industry Consulting Services International (BICSI):
 - a. BICSI TDMM - Telecommunications Distribution Methods Manual.
- 4. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department:
 - 1) Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
- 5. National Electric Manufacturer's Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- 6. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
- 7. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
- 8. Telecommunications Industry Association (TIA):
 - a. TIA 569-B – Commercial Building Standard for Telecommunications Pathways and Spaces.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. UL Building Materials Directory.
 - b. UL Fire Resistance Directory.
 - c. UL Online Certifications Directory,
<https://www.ul.com/ul-databases-and-directories/>.
 - 1) UL Fire Resistance Directory (Fire Resistance Ratings).
 - d. UL 797 – Electrical Metallic Tubing – Steel.
 - e. UL 2079 – Standard for Tests for Fire Resistance of Building Joint systems.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the routing and location of the conduits and other raceways with other trades and with the building construction to avoid conflicts.
 - 2. Where conduits pass through the roof, coordinate communications pathway installation with the roofing installer.



1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Electrical metallic tubing (EMT).
 - 2) Rigid Metal Conduit (RMC)
 - 3) Expansion joint fittings.
 - 4) Thruwall sealing fittings.
 - 5) Fire-seal fittings.
 - 6) Sealing material for sealing fittings.
 - 7) Insulated bushings.
 - 8) Pulling in wire.
 - 9) Thread lubricant/sealant.
 - 10) Wireways and wiring troughs.
 - 11) Cable trays.
 - 12) Innerduct.
 - 13) Junction boxes/pull boxes.
 - 14) Conduit
 - b. Shop Drawings:
 - 1) Plan and section drawings detailing the proposed communications pathway routing.
 - c. Certificates:
 - 1) Fire Stopping Manufacturer's Certificate.
 - d. Qualification Statements:
 - 1) Fire Stopping Installer's Certificate.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Firestopping manufacturer's instructions.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Manufacturer's warranties on all components installed under this Section.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:



1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Provide only UL listed and labeled conduits.
- B. Qualifications:
1. Fire Stopping Installer's Qualifications:
 - a. Employ a fire stopping installer who has been trained and approved by the fire stopping manufacturer to perform fire stopping work, and who has specialized in the installation of work similar to that required for this Contract.
- C. Certifications:
1. Fire Stopping Manufacturer's Certificate:
 - a. Submit a Fire Stopping Manufacturer's Certificate, signed by the manufacturer and certifying the materials he has supplied comply with the specified performance characteristics and physical properties for fire stopping materials, to the Program/Project Manager for approval.
 2. Fire Stopping Installer's Certificate:
 - a. Submit a Fire Stopping Installer's Certificate, certifying the installer is manufacturer-trained and approved to properly install the fire stopping materials.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
1. Deliver materials and equipment in a clean condition.
 - a. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.
 2. Provide equipment needed for unloading operations, and have such equipment on the Site to perform unloading work when the material and equipment is delivered.
 - a. If possible, clearly identify pick-points or lift-points on communications equipment crating and packaging.
 - b. In the absence of pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.
 - c. When unloading the materials and equipment, provide special lifting harnesses or apparatus as required by the manufacturers.
 3. Inspect materials and equipment for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
1. Handle materials and equipment in accordance with the manufacturer's written instructions.



2. Store all products whether on-site or off-site, indoors on blocking or pallets.
3. Follow the manufacturer's written instructions for storing the items.
4. Except for communications conduit, store communications equipment and products under cover in heated warehouses or in enclosed buildings that provide protection from the weather on all sides and are equipped with auxiliary heat.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Provide a minimum one (1) year written manufacturer's warranty on all components installed under this Section.
 - a. Submit the manufacturer's warranties to the Program/Project Manager.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Substitution Limitations:
 - a. Comply with the substitution requirements specified in Section 16702, Basic Communications Materials and Methods.
2. Product Options:
 - a. Comply with the product option requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 1) The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not meant to preclude other manufacturers that may be qualified to provide communications components.
 - 2) Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
 - 3) Submit documentation for the components proposed to be installed under this Contract as required.

B. Regulatory Requirements:

1. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work, including among others the following:
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - c. Aviation Supplement to City of Phoenix Information Technology Standards.



C. Design Criteria:

1. Comply with the requirements specified in Annex B, "Application Information for Ampacity Calculation", in NFPA 70, the National Electrical Code (NEC).
2. Where the sizes of conduit and other raceway are not specifically shown on the Contract Drawings, size the conduits in accordance with the requirements of BICSI TDMM and NFPA 70, the National Electrical Code.
 - a. Do not provide conduit sized less than 1-inch.
 - b. Submit catalog cut sheets of the proposed conduit, innerduct, and associated hardware prior to any installation.
 - c. Submit plan and section drawings detailing the proposed pathway routing prior to any installation.
3. Use communications conduits, cable tray, and other raceways only for communications cabling.
 - a. Do not route power cabling within the same raceway with communications cabling.
4. Conflicts:
 - a. If conflicts between referenced requirements arise or between the requirements of referenced documents and the Contract Documents, as specified in Section 16702, Basic Communications Materials and Methods, comply with the one establishing the more stringent requirements.

D. Materials:

1. Conduit and Accessories:
 - a. Electrical Metallic Tubing (EMT):
 - 1) Provide high strength, zinc-coated electrical metallic tubing (EMT) complying with the requirements specified in UL 797 and ANSI C80.3, and having a minimum conduit size of 1 inch.
 - 2) Provide compression type fittings having the same finish and material as the tubing and with insulated throats for the electrical metallic tubing.
 - a) For all metallic couplings, connectors and fittings provide malleable iron or steel finished with zinc plating or galvanizing.
 - 3) Manufacturers:
 - a) Allied Tube and Conduit, www.alliedtube.com.
 - b) Triangle Conduit and Cable Company
 - c) Republic Conduit, www.republic-conduit.com.
 - d) Approved equal.
 - b. Non-Metallic Conduit:
 - 1) Electrical Plastic Tubing and Conduit:
 - a) Rigid Polyvinyl Chloride (PVC) Conduit:
 - (1) Provide high impact PVC conduit conforming to the requirements of NEMA TC 2 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.



- (a) For indoor use, provide Schedule 40 conduit.
 - (b) For encasement in concrete, provide Schedule 40, Type EB or Type DB, conduit tubing.
 - (c) Use material that at 78 degrees Fahrenheit has a tensile strength exceeding 5500 psi, a flexural strength exceeding 11,000 psi, and a compressive strength exceeding 800 psi,
- (2) Provide PVC conduits that are UL listed, labeled, or approved for both underground and above ground use.
- b) Manufacturers:
 - (1) Lamson & Sessions, Carlon®, www.carlon.com.
 - (2) Queen City Plastics, Inc., www.queencityplastics.com.
 - (3) Manhattan Wire, Inc., www.manhattanwire.com
 - (4) Approved equal.
- 2) Non-Metallic Conduit Solvent:
 - a) Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D 2564.
- c. Expansion Joint Fittings:
 - 1) Provide approved watertight weatherproof telescopic type expansion joint fittings that permit two-way movement up to 4 inches, and that are equipped with approved bonding jumpers around or through each fitting.
 - 2) Manufacturers:
 - a) EGS/O-Z/Gedney, Type TX, www.o-zgedney.com.
 - b) EGS/Appleton Electric, Type XJ and BJ, www.appletonelec.com.
 - c) Approved equal.
- d. Thruwall Sealing Fittings:
 - 1) Provide thruwall sealing fittings for sealing around a conduit passing through a wall or floor.
 - 2) Manufacturers:
 - a) EGS/O-Z/Gedney, Type WSK, www.o-zgedney.com.
 - b) Approved equal.
- e. Fire-Seal Fittings:
 - 1) Provide fire-seal fittings.
 - 2) Manufacturers:
 - a) EGS/O-Z/Gedney, Type CFSI, www.o-zgedney.com.
 - b) Approved equal.
- f. Sealing Material for Sealing Fittings:
 - 1) Provide sealing material for sealing fittings capable of being injected into the fitting and hardening to produce an explosion proof seal.
 - 1) Manufacturers:
 - a) Crouse-Hinds, www.crouse-hinds.com:



- (1) Chico® X Fiber and Chico® A sealing compound.
 - b) EGS/Appleton Electric, www.appletonelec.com.
 - (1) Kwiko® A sealing cement and fiber filler.
 - c) Approved equal.
 - g. Insulated Bushings:
 - 1) Provide specification grade insulated bushings for rigid metal, IMC, and EMT conduit to protect insulated conductors from abrasion during pulling and from mechanical vibration, and to provide voltage a gradient between live conductors and ground at the point of electrical and mechanical stress on the conductor insulation.
 - 1) Manufacturers:
 - a) EGS/O-Z/Gedney, Type B or SBT as applicable, www.o-zgedney.com.
 - b) Thomas & Betts Corporation; Steel City® BI 900 Series, BU 500 Series, or TC700 Series as applicable; <http://www.tnb.com>.
 - c) Approved equal.
 - h. Pulling in Wire:
 - 1) Provide 1250pound nylon pull rope.
 - i. Thread Lubricant/Sealant:
 - 1) For joints for non-heat producing elements, provide
 - a) Manufacturers:
 - (1) Crouse-Hinds, Type STL, www.crouse-hinds.com.
 - (2) Thomas & Betts Corporation; Kopr-Shield; <http://www.tnb.com>.
 - (3) Approved equal.
 - 2) For joints for heat producing elements such as lighting fixtures, provide
 - a) Manufacturers:
 - (1) Crouse-Hinds, Type HTL, www.crouse-hinds.com.
 - (2) Approved equal.
- 2. Wireways and Wiring Troughs:
 - a. Provide wireways and wiring troughs fabricated from code gauge galvanized steel, sized as shown on the Contract Drawings, or as required by NFPA 70, the National Electrical Code.
 - b. Provide screwed covers.
 - c. Where the Contract Drawings indicate rain tight wireways, provide galvanized wireways complying with the requirements for watertight enclosures as specified in NEMA 250.
- 3. Cable Trays:
 - a. Provide aluminum ladder rack cable trays, hot dip mill-galvanized in accordance with the requirements of ASTM A 653/A 653M, and hot dip galvanized after fabrication in accordance with the requirements of ASTM A 123/A 123M.



- 1) Do not provide center hung cable tray.
 - 2) Provide cable trays in 10foot lengths.
 - 3) For riser cables entering from floor sleeves and slots, provide vertical cable tray sections secured to the floor.
 - 4) For cable tray racks installed above equipment racks and cabinets, provide runway drop-offs.
 - b. Provide cable trays classified by UL as an equipment grounding conductor.
 - 1) Provide splices, supports, and other fittings necessary to provide a complete, continuously grounded system.
 - c. Provide cable trays that comply with the requirements specified in Article 318.5 of NFPA 70, the National Electrical code (NEC).
 - d. Provide appropriate connectors and mounting brackets to properly mount the cable tray.
 - e. Provide cable trays having the following dimensions unless otherwise specified or indicated on the Contract Drawings:
 - 1) Minimum Width: 12 inches.
 - 2) Minimum Load Depth: 4 inches.
 - 3) Minimum Rung Diameter: 1 inch.
 - 4) Maximum Rung Spacing: 12 inches.
 - f. Finish:
 - 1) Provide a surface treatment consisting of polyester powder-coated over electrodeposited zinc plating.
 - 2) Color: ASA 61 black.
 - g. Manufacturers:
 - 1) Cooper B-Line, www.b-line.com.
 - 2) Allied Electrical™ Group, Cope® Cable Tray, www.alliedeg.com/cope.
 - 3) Chatsworth Products, Inc., www.chatsworth.com.
 - 4) Hoffman, www.hoffmanonline.com.
 - 5) Cablofil, Inc., EZ Tray, www.cablofil.com
 - 6) GS Metals Corporation, Flextray, www.flextray.com.
4. Innerduct:
 - a. Provide innerduct complying with Articles 725, 760, and 800 of NFPA 70, the National Electrical Code, of the following sizes:
 - 1) 1/2 inch.
 - 2) 3/4 inch.
 - 3) 1 inch.
 - 4) 1-1/4 inch.
 - 5) 1-1/2 inch.
 - 6) 2 inch.
 - b. For Innerduct placed in spaces used as air returns, or connected with air handling plenums or building ventilation, provide low-smoke, fire retarding innerduct.
5. Junction Boxes/Pull Boxes:



- a. Unless otherwise specified, provide NEMA Type 1 pull boxes constructed of 14 or 12-gauge steel with an ANSI/ASA 61 grey polyester powder finish over phosphatized or galvanized surfaces inside and out.
- b. Provide pull boxes having flat, removable covers fastened with plated steel screws through unique keyhole screw slots in the cover that permit removal of the cover without extracting the screws.
- c. Provide pull boxes having appropriate provisioning for grounding.
- d. Size the pull boxes according to Table 16705-1 unless otherwise specified:

Table 16705-1 Communications Pull Box Sizes				
Maximum Trade Size of Conduit (Inches)	Minimum Box Size (inches)			Increased Width For Each Additional Conduit (Inches)
	Width	Length	Depth	
0.75	4	12	3	2
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

2.02 ACCESSORIES

- A. Firestopping Materials:
 1. Provide firestopping materials complying with the requirements specified in Section 07850, Through Penetration Firestopping Systems.
- B. Hangers and Supports:
 1. Provide hangers and supports as specified in Section 16070, Hangers and Supports, and as specified herein.
 2. Conduit Clamps:
 - a. Provide galvanized malleable iron conduit clamps.
 3. Conduit and Cable Tray Hangers:



- a. Provide hangers consisting of channel or Unistrut® suspended on 1/2-inch threaded rods.
- b. Manufacturer:
 - 1) Unistrut®, <http://unistrut.com>.
 - 2) Approved equal.
- C. Labels:
 - 1. Provide labels for communications pathways that comply with the requirements specified in Section 16076, Communications Identification.
- D. Communications Equipment Room Fittings:
 - 1. Provide communications equipment room fittings complying with the requirements specified in Section 16711, Communications Equipment Room Fittings.
- E. Communications Connecting Devices and Adaptors:
 - 1. Provide communications connecting devices and adaptors complying with the requirements specified in Section 16714, Communications Connecting Cords, Devices, and Adaptors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that new conduit runs will not interfere with existing or new systems within each facility.
 - 2. Verify that substrate conditions are acceptable for installing firestopping materials in accordance with the manufacturer's instructions.
 - a. Submit the firestopping manufacturer's instructions to the Program/Project Manager for information.

3.02 INSTALLATION

- A. Mechanically and electrically connect communications raceways to all boxes and fittings, and properly ground the raceways in accordance with the requirements of Section 16061, Communications Grounding and Bonding.
- B. Installing Communications Conduit and Innerduct:
 - 1. Install electrical metallic tubing (EMT) with compression fittings and couplings.
 - a. Ream conduit to eliminate sharp edges, and terminate the conduit with an insulated bushing.
 - b. Where conduits terminate in a thread less opening, provide locknuts on both the inside and outside of the box or enclosure, and fit the conduit end with an insulating bushing.



- c. Where bonding is required, equip the end of the conduit with an insulated metallic grounding and bonding bushing.
2. Do not install sections of conduit longer than 30m (100 feet), or that contain more than two 90-degree bends between pull points or pull boxes.
 - a. For bends in 2 inch or smaller conduit, provide inside bend radii at least 6 times the internal diameter.
 - b. For bends in conduit larger than 2 inches, provide inside bend radii at least 10 times the internal diameter of the conduit.
 - c. For bends underground, provide inside bend radii at least 12 feet.
3. Terminate conduit protruding through the floor 4 inches above the floor surface.
4. Place a fish tape or measured pull cord in installed conduit and innerduct.
 - a. Provide a pull rope in each empty conduit and innerduct.
5. In stud walls or above suspended ceilings, install only electrical metallic tubing raceways.
 - a. Do not use PVC conduit.
6. Do not use electrical metallic tubing (EMT) for service entrance conductors.
7. Do not use electrical metallic tubing (EMT) for outdoor rated cable.
8. Do not embed conduit in the required fire protective covering of a structural member that is to be individually encased in accordance with the Phoenix Building Construction Code and Amendments.
9. Provide expansion fittings where conduits pass through building expansion joints.
10. Unless specifically noted otherwise on the Contract Drawings, do not allow a single conduit run extending from an intermediate distribution frame (IDF) to serve more than 2 jacks.
11. Conduit Support:
 - a. Properly support conduits using conduit clamps for individual runs.
 - b. Support multiple runs on channel adequately secured to the walls or hung from the structure above with the conduits fastened to the channel with conduit clamps designed for the purpose.
 - c. Support conduit 2 inches and larger at 8 feet on center maximum, and support conduit 1-1/2 inch and smaller at 10 feet on center maximum.
12. Conduit Identification:
 - a. Color code all communications conduits with yellow tape marked "communications", and labeled with the location of the conduit's beginning and ending points.
 - b. Label the conduit at the beginning and ending points and at every 50 feet where the conduit is exposed.
13. Below Grade Conduit:
 - a. Install below grade conduit in conformance with the requirements of Section 02582, Underground Ducts and Manholes.
 - 1) For conduits that pass under building support walls, provide a minimum of 3 inches of concrete encasement all around.



- 2) For underground and concrete encased duct banks, provide non-metallic conduit spacers.
 - a) Provide sufficient space to allow pouring the concrete envelope without displacing or shifting the individual conduits.
 - b) Encased duct banks shall be provided with red dye.
 - b. Install conduit spacers at intervals not exceeding 5 feet.
 14. All conduit shall be painted to meet Aviation Design Standards for electrical, fire alarm, communications, and control conduits.
- C. Connecting Communications Conduit to Sheet Metal Boxes and Enclosures:
 1. Place a color-coded pull or splice box in a conduit run where the length is over 30 m (100 feet), there are more than two 90-degree bends, or there is a reverse bend in the run.
 - a. Place pull or splice boxes in an exposed, readily accessible location.
 2. To connect conduit to NEMA Type 1 boxes and enclosures, provide electrical metallic tubing (EMT) having compression box connectors with insulated throats.
 3. To connect conduit to NEMA Types 3R, 4, 4X, and 12 boxes, provide insulated bushings and sealing locknuts or hubs.
 4. Where conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit.
 - a. Bond the bushings to the ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
 5. Install sealing bushings within conduits which have entered a building from outside, whether from above or below grade.
- D. Installing Communications Cable Trays:
 1. Provide hangers affixed to the structure above by 1/2-inch threaded rod to support cable trays.
 - a. Within the cable tray, fit the threaded rod with a 6-inch PVC tube to protect the cables.
 2. Provide cable tray horizontal bends, cross fittings, and tees having 3-inch diameter holes on 6 inch centers with the edge of each hole covered by a grommet to protect cables.
 3. Unless otherwise specified or indicated on the Contract Drawings, locate cable trays 7 feet 6 inches above the finished floor.
 4. Provide proper clearance between HVAC ducting or other obstacles and cable trays.
 5. Ground and bond all cable tray and ladder racking to the telecommunications grounding busbar (TGB) in the communications room.
- E. Installing Communications Junction Boxes/Pull Boxes:



1. Install junction boxes/pull boxes in sections of conduit that are 100 feet or more in length, that contain more than two 90-degree bends, or that contain bends that are 180 degrees or more in the aggregate.
 - a. Do not provide a junction boxes/pull boxes in lieu of a conduit bend.
 2. Install junction boxes/pull boxes in an easily accessible location with unobstructed entry to the junction box/pull box access panel.
 3. Support the pull boxes on all 4 corners in so the pull box is not supported by either the cable running through the pull box or the conduit attached to the pull box.
- F. Seals:
1. To prevent the ingress of water, dust, and other foreign material, seal all conduit and cabinet entrances with an approved, re-enterable sealant material.
 2. Where raceways pass through walls, partitions, and floors, seal the penetrations so a neat installation results, and the integrity of the waterproofing or fireproofing of the structure, as applicable, is maintained.
 3. Seal raceways entering a building from underground to prevent water, moisture, gas, or any other foreign matter from entering the building.
 4. Seal service conduits in accordance with NFPA 70, 230.8.
- G. Identification:
1. Identify communications pathways in accordance with the requirements specified in Section 16076, Communications Identification.
- H. Special Techniques:
1. Where multiple innerducts are placed in the same raceway, provide each innerduct with a different color.
- I. Interface with Other Work:
1. Do not place cabling or innerduct in plenums without written approval from the Program/Project Manager.
 2. Install fire stopping materials for communications pathways in accordance with the requirements of Section 07850, Through Penetration Firestopping Systems.
 3. Use cable tray to route bulk telecommunications equipment within the Main Distribution Frame (MDF).
- J. Systems Integration:
1. Install all fiber optic cable within innerduct.
 2. Provide backbone fiber optic cable and copper cable as specified in Section 16712, Communications Backbone Cabling.
 3. Provide horizontal cabling for supporting voice, data and video communications as specified in Section 16713, Communications Horizontal Cabling.



3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:
 - a. Test communications pathways in accordance with the requirements specified in Section 16081, Communications Testing.
 - 2. Inspections:
 - a. Code officials and/or building inspectors will inspect the installation to confirm the proper installation using manufacturer guidelines.

3.04 SYSTEM STARTUP

- A. Provide system startup as specified in Section 16702, Basic Communications Materials and Methods.

3.05 CLEANING

- A. Clean conduits before wires are pulled using mandrel. Provide report for approval.

3.06 PROTECTION

- A. Protect installed products from damage during construction operations until Final Acceptance.
- B. To prevent the entrance of construction dirt and debris, plug all conduits after installation.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	03/02/2018	N/A	3.02.B.12	Change color of conduit from orange to yellow.
1	04/06/2018	N/A	1.02.B.9, 2.01.D.1.a	Corrected address





SECTION 16711

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the building out of Telecommunications Equipment Rooms (MDF/IDFs) to be used for supporting telecommunications and other special systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16062 - Telecommunications Grounding and Bonding.
 - 4. Section 16702 - Basic Communications Materials and Methods.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AFF: Above the finished floor elevation.
 - 2. CAD: Computer Aided Drafting.
 - 3. HVAC: Heating, ventilation, and air conditioning.
 - 4. IDF: Intermediate Distribution Frame.
 - 5. MDF: Main Distribution Frame.
 - 6. NEC: The National Electrical Code.
 - 7. OSP: Outside plant.
 - 8. PDS: Premises Distribution System.
 - 9. RMU: Rack Mounting Units.
 - 10. SCS: Structured cabling system.
 - 11. TGB: Telecommunications grounding busbar.
 - 12. TMGB: Telecommunications Main Grounding Busbar.
 - 13. VAC: Volts of alternating current.
- B. Reference Standards:
 - 1. American National Standards Institute (ANSI):
 - a. ANSI/J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 - b. ANSI/ASA Color Charts.
 - 2. Building Industry Consulting Services International (BICSI):
 - a. ANSI/NECA/BICSI 568 – Standard, Installing Commercial Building Telecommunications Cabling.
 - b. BICSI TDMM - Telecommunications Distribution Methods Manual.
 - c. BICSI OSPDRM – Outside Plant Design Manual.
 - d. BICSI ESSDRM – Electronic Safety and Security Reference Manual.



- e. BICSI ITSIM – Information Transport Systems Installation Manual.
- 3. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department:
 - 1) Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
- 4. Electronic Industries Association (EIA):
 - a. EIA-310-D – Cabinets, Racks, Panels and Associated Equipment.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
- 6. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
- 7. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - b. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA-568-B.3 – Optical Fiber Cabling Components Standard.
- 8. Telecommunications Industry Association (TIA):
 - a. TIA-569-B – Commercial Building Standard for Telecommunications Pathways.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. UL Qualification Tests and Follow-Up Service Requirements.
 - b. UL Product Directories.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate all communications work with the Program/Project Manager and the approved Contract schedule.
 - a. Adhere to the approved installation schedule.
 - b. Give required notices for items affecting the Contract schedule.
 - 2. Make every effort to schedule the Work of this Section so disruption of public areas during installation is limited.
- B. Pre-Installation Meetings:
 - 1. The communications equipment Subcontractor must attend all construction meetings related to the communication equipment installation scheduled by the Contractor.
- C. Scheduling:



1. Adhere to the installation schedule approved by the Program/Project Manager.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

a. Product Data:

- 1) Equipment racks.
- 2) Equipment cabinets.
- 3) Floor frames.
- 4) Vertical wire menders.
- 5) Horizontal wire menders (patch cord organizers).
- 6) Cable tray.
- 7) Grounding bars.

b. Shop Drawings:

- 1) Proposed layout modifications for each affected or new communications rooms in the airport.

c. Qualification Statements:

- 1) Communications equipment room fitting manufacturer's qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

a. Manufacturer's Instructions:

- 1) Manufacturer's installation guidelines.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

a. Warranty Documentation:

- 1) Manufacturer's standard warranties.

b. Record Documentation:

- 1) Record Drawings of the completed layout of each communications room.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:

- a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.



2. Fire Extinguishers:
 - a. Provide and maintain portable fire extinguishers within 75 feet travel distance from any part of the occupied space within the main distribution frame (MDF) in accordance with local code requirements.
 - 1) Furnish a fire extinguisher of the 2-A 10-B:C size and minimum rating.

B. Qualifications:

1. Manufacturer Qualifications:
 - a. Communications Equipment Room Fittings Manufacturer's Qualifications:
 - 1) Obtain communications equipment room fittings from experienced manufacturers who have been regularly engaged in the production of telecommunications equipment room fittings of the types to be installed under this Contract for a minimum period of 5 years.
 - 2) Submit the communications equipment room fitting manufacturers' qualifications to the Program/Project Manager for approval.
2. Structured Cabling System Installer's Qualifications:
 - a. Employ the structured cabling system installer specified in Section 16702, Basic Communications Materials and Methods, for installing the communications equipment room fittings.

C. Certifications:

1. Underwriters Laboratory, Inc. Certifications:
 - a. Provide floor frames complying with the appropriate UL Qualification Tests and Follow-Up Service Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Equipment Racks:
 - a. Ship equipment racks with the hardware necessary to assemble the frame included.
 - b. Pack equipment racks in cartons with suitable shipping inserts so no damage occurs to the rack finish.

B. Storage and Handling Requirements:

1. Do not allow the finish of the equipment racks to be scratched, chipped or marred.

1.07 SITE CONDITIONS

A. Ambient Conditions:

1. Environmental Conditions:



- a. Ensure that there is a continuous and dedicated environmental control (24 hours per day, 365 days per year) in communications equipment rooms.
 - b. Ensure that the air handling system for the equipment rooms is capable of providing positive air flow and cooling, even during times when the main building systems are shut down.
 - 1) Separate air handlers and/or small stand-alone cooling systems that are thermostatically controlled in this space may need to be provided.
 - 2) Maintain a positive air pressure differential with respect to surrounding areas.
 - 3) Provide heating, ventilation, and air conditioning sensors and control equipment in the communications rooms.
 - c. Maintain the room temperature between 64 degrees Fahrenheit and 75 degrees Fahrenheit, with a relative humidity between 30 percent and 55 percent.
 - 1) Communications equipment rooms are not to be located in any place that may be subject to water or steam infiltration, humidity from nearby water or stream, heat, and any other corrosive atmospheric or environmental conditions.
 - d. Protect the communications room from contaminants and pollutants that could affect operation and material integrity of the installed communications equipment.
 - 1) If contaminants are present in concentrations greater than indicated in Table 8.2-2 of TIA-569-B, provide vapor barriers, positive room pressure, or absolute filters.
2. Lighting:
- a. Provide adequate lighting, considered to be a minimum of 50 foot-candles measured 3 feet above the finished floor, in the communications rooms.
 - b. Mount the light fixtures a minimum of 8 feet, 6 inches above the finished floor (AFF).
 - c. Locate the light switches near the entrances of the communications rooms.
 - d. Properly place emergency lighting so an absence of light will not hamper emergency exiting.
- B. Existing Conditions:
- 1. If the existing condition of any of the following items is not as indicated herein, contact the Program/Project Manager immediately.
 - a. Access to Communications Rooms:
 - 1) Access to the communications rooms will be directly from hallways; and not through offices, janitorial rooms, or mechanical rooms.
 - 2) Doors:



- a) Ensure that the communications equipment room doors are lockable and keyed separately from other facility doors, that the doors open outward, and that they are a minimum of 3 feet wide by 7 feet 5 inches tall.
 - (1) Ensure that there is access for future equipment changes within the room.
 - b) Ensure that the doors are fire rated for a minimum of 1 hour or more as required by local code requirements.
- b. Signage:
 - 1) Ensure that communications equipment room signage is consistent with Phoenix Sky Harbor International Airport standards.
- c. Floors:
 - 1) To minimize dust and static electricity, ensure that the communications equipment room floors are sealed concrete.
 - a) Carpet is strictly prohibited on communications equipment room floors.
 - 2) Floor Capacity:
 - a) Ensure that the communications room floor is designed for a minimum distributed load rating of 100 pounds-force per square foot, and a minimum concentrated load rating of at least 2000 pounds-force.
- d. Electrical Power:
 - 1) Provide a minimum of two dedicated 3-wire, 120 VAC, 20-Ampere rated quad electrical outlets on separate branch circuits located on active equipment racks 24 inches above the finished floor (AFF) in each communications room.
 - a) Unless otherwise specified, provide duplex 20R spade receptacles.
 - 2) Provide separate duplex 120 VAC convenience outlets 18 inches above the finished floor at 6-foot intervals around perimeter walls in each communications room.
 - a) Locate the outlets on non-switched circuits, and identify and label them.
 - 3) Provide equipment to supply power to the equipment located within the communications rooms from a panel located within the room.
 - a) Provide power for the lighting and the telecommunications equipment from separate power panels.
- e. Electrical Grounding:
 - 1) Provide an electrical ground on a 4-inch or larger busbar as defined by Article 250-71(b) in NFPA 70, the National Electrical Code (NEC), for the communications room located near, but not behind, the riser sleeves between floors.



- 2) Connect the grounding bar to a main building ground electrode, complying with the requirements specified in ANSI/J-STD-607-A.
- f. Electromagnetic Interference:
 - 1) The communications rooms are not to be located near electrical power supply transformers, motors, generators, x-ray equipment, radio transmitters, induction heating devices, and other potential sources of electromagnetic interference.
- g. Uninterruptible Power Supplies:
 - 1) Provide a single Uninterruptible Power Supply capable of supporting the active electronics within the main distribution frame (MDF) for a minimum of 20 minutes.
 - 2) Provide an individual rack-mounted Uninterruptible Power Supply for each intermediate distribution frame (IDF) capable of supporting the equipment within that rack for a minimum of 20 minutes.
- h. Building Automation:
 - 1) Additional equipment, such as fire alarm panels and/or building monitoring devices, will not be housed in the communications equipment rooms.
 - a) Separate space for these services will be provided as part of the electrical room or in a separate space.
 - 2) Appropriate fire detection/protection systems will be provided in the communications equipment rooms in accordance with the City of Phoenix code requirements.

1.08 WARRANTY

- A. Manufacturer Warranty:
 1. Provide the manufacturer's standard warranty for the products provided under this Section.
 2. Submit the warranty to the Program/Project Manager.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 1. Substitution Limitations:
 - a. Comply with the substitution requirements specified in Section 16702, Basic Communications Materials and Methods.
 2. Product Options:
 - a. Comply with the product option requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 1) The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not



meant to preclude other manufacturers that may be qualified to provide communications components.

- 2) Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
- 3) Submit documentation for the components proposed to be installed under this Contract as required.

B. Description:

1. Regulatory Requirements:

- a. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work of this Section, including among others the following:
 - 1) Phoenix Building Construction Code and Amendments.
 - 2) City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - 3) Aviation Supplement to City of Phoenix information Technology Standards.

C. Design Criteria:

1. Provide the materials as described herein and shown on the Contract Drawings, and provide the communications equipment room fittings, necessary to interconnect all system equipment, including equipment located in Telecommunications Rooms.
 - a. Comply with the requirements specified in Section 16702, Basic Communications Materials and Methods.
 - b. Design all racks and cabinets to be floor mountable.
2. Should there be any discrepancies or a question of intent, refer the matter to the Program/Project Manager for a decision before ordering any equipment and materials, and before starting any related work.
3. Shop Drawings:
 - a. Prior to performing the Work of this Section, prepare Shop Drawings of the proposed layout modifications for each affected communications room in the airport.
 - b. Submit the Shop Drawings to the Program/Project Manager for approval.
4. Conflicts:
 - a. If conflicts between referenced requirements arise, comply with the one establishing the more stringent requirements.
 - b. If conflicts between referenced requirements and the Contract Documents arise, comply with the one establishing the more stringent requirements.

D. Materials:

1. Equipment Racks, Cabinets, and Shelves:
 - a. Equipment Racks:



- 1) Provide free standing, self-supporting equipment racks fabricated from extruded lightweight aluminum Alloy 6061-T6, and designed for cable and jumper management and to be permanently mounted on the floor with bolt-down kits.
- 2) Provide equipment racks capable of supporting and organizing electronic equipment, cross-connection and/or termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as required by the communication system design; and equipped for electrical grounds complying with the requirements specified in ANSI/J-STD-607-A.
 - a) Provide racks having a mounting width capable of supporting conventional 19-inch equipment.
 - b) Provide 7-foot tall racks having 6-inch wide channels on each side, and extruded aluminum angles at the top and base, to provide support.
 - c) Provide hardware to organize and support cabling and patch cords in the vertical and horizontal planes.
 - d) Provide standard grade frames capable of supporting a uniformly distributed weight of 750 pounds.
- 3) To facilitate easy equipment installation, provide a strong and durable fastening system having mounting screws with pilot points and screw holes with roll-formed threads.
- 4) Equipment Rack Specifications:
 - a) Provide equipment racks complying with the equipment rack specifications in Table 16711-1.

Table 16711-1 Equipment Rack Specifications	
Parameter	Requirement
Color	Black
Dimensions	7 feet by x 20-5/16 inches by 18 inches with 19 inch center mounting
Base footprint	20.25 inches wide by 18 inches deep
Hole pattern	5/8 inch - 5/8m inch - 1/2inch alternating in accordance with EIA-310-D
Rack Mounting Units (RMU)	45
Mounting screws	12-24 thread with combination Phillips/straight heads and pilot points.

- 5) Manufacturers:
 - a) Chatsworth Products, Inc., Part Number 66353-703, www.chatsworth.com.



- b) Approved equal.
- b. Equipment Cabinets:
 - 1) Free Standing Cabinet
 - a) Provide standard free standing equipment cabinets having 19-inch rack mounting options for equipment; designed to accommodate server rail kits from Compac, IBM, and Dell; and unless otherwise indicated on the Contract Drawings designed to be permanently mounted on the floor with bolt-down kits.
 - b) Provide equipment cabinets having the following features:
 - (1) A removable front locking door fabricated from smoked Plexiglas, and hinged on the right side.
 - (2) A removable rear locking door, louvered at both top and bottom, and hinged on the right side.
 - (3) Push button lift-off locking side panels.
 - (4) A perforated top panel designed for ventilation, and mounting an exhaust fan.
 - (5) An open base.
 - (6) Two 6-foot, 6-port, 20 Amp power strips.
 - (7) Unless otherwise indicated on the Contract Drawings, a grounding bus.
 - c) If cabinet drawings are provided for this Contract, layout equipment cabinet layouts accordingly.
 - 2) Wall Mounted Cabinet:
 - a) Provide wall mounted cabinets consisting of a lockable enclosure that provides standard 19-inch rack mounting options for equipment, a minimum of 7 rack units of mounting space, and capable of accommodating both active and passive components simultaneously.
- c. Floor Frames:
 - 1) Provide high capacity floor frames designed for high density terminations without congestion, and having cable runway support, junctioning bolts, a ground bus, and separate horizontal and vertical paths for jumpers.
 - a) Provide floor frames capable of mounting 100-pair or 300-pair 110 blocks.
 - b) Provide uprights fabricated from structural grade aluminum Alloy 6061-T6.
 - c) Provide floor frames capable of supporting the termination of up to 9000 pairs of copper conductors.
 - 2) Provide only floor frames that are UL-listed in accordance with the UL Qualification Tests and Follow-Up Service Requirements.
- 2. Cable Management:
 - a. Vertical Wire Menders:



- 1) Provide vertical wire menders that create an organized path for routing patch or cross-connect cables between distribution racks.
- 2) Provide vertical wire menders that have usable dimensions of 6 inches by 7 feet, and are compatible with a free standing 19-inch rack.
- 3) Manufacturers:
 - a) Chatsworth Products, Inc., Part Number 14831-703, www.chatsworth.com.
 - b) Approved equal.
- b. Horizontal Wire Menders (Patch Cord Organizers):
 - 1) Provide horizontal wire menders between all devices mounted within a rack or cabinet, and capable of organized movement for routing horizontal and vertical patch cables on distribution racks.
 - 2) Manufacturers:
 - a) Chatsworth Products, Inc., Part Number 30530-719, www.chatsworth.com.
 - b) Approved equal.
3. Cable Tray:
 - a. Provide cable trays that are at least 12 inches wide, and that include vertical sections secured to the floor for riser cables entering from floor sleeves and slots, and runway drop-offs for racks installed above equipment racks and cabinets.
 - b. Provide splices, supports, and other fittings necessary for a complete, continuously grounded cable tray system.
 - 1) Provide a cable tray system UL-Classified as equipment grounding conductor, and meeting the requirements specified in Article 318-5 of NFPA 70, the National Electric Code.
 - c. Dimensions:
 - 1) The actual dimensions are indicated on the Contract Drawings; however, if no dimensions are indicated provide cable trays having the following dimensions:
 - a) Length: 10 feet.
 - b) Width, Minimum: 6 inches.
 - c) Load Depth, Minimum: 4 inches.
 - 2) There may be more than one size cable tray in the design.
 - d. Cable Tray Finish:
 - 1) Provide an ANSI/ASA 61 black polyester powder-coated surface treatment over electrodeposited zinc plating.
 - e. Manufacturers:
 - 1) Cooper B-Line, www.b-line.com.
 - 2) Chatsworth Products, Inc., www.chatsworth.com.
 - 3) Hoffman, www.hoffmanonline.com.
 - 4) Cablofil, Inc., EZ Tray, www.cablofil.com
 - 5) GS Metals Corporation, Flextray, www.flextray.com.



2.02 ACCESSORIES

- A. Grounding Bars:
 - 1. Telecommunications Main Grounding Busbar (TMGB):
 - a. Provide a telecommunications main grounding busbar (TMGB) as specified in Section 16062, Telecommunications Grounding and Bonding.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Grounding:
 - a. Verify that the main telecommunications grounding system is properly installed and has been tested in accordance with the requirements of Section 16062, Communications Grounding and Bonding.
 - 2. Pathway Installation:
 - a. Verify that the communications conduit, raceways, and boxes are properly installed in accordance with the recommended practices of BICSI (ANSI/NECA/BICSI 568, BICSI TDMM, BICSI OSPDRM, BICSI ESSDRM, and BICSI ITSIM), ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3; and the PSHIA Premises Distribution System Standards.
 - b. Verify that the conduit has a minimum diameter of 1 inch.
 - 3. Fire Protection:
 - a. Verify that the main distribution frame (MDF) is equipped with a smoke/fire detection/protection system that is fully integrated with the existing building fire detection system and the Premises Distribution System (PDS) design standards.
 - 4. Clearances:
 - a. Verify that to provide space over the equipment frames for cables and suspended racks, ceiling protrusions allow a minimum clear height of 8 feet 6 inches.

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Line the walls of the communications equipment rooms with 8 feet high Trade Size 3/4-inch AC-grade fire rated plywood.
 - a. Mount the plywood vertically by securely fastening it to the wall-framing members starting 2 inches above the finished floor (AFF).
 - 2. Paint the plywood with 2 coats of white fire-retardant paint, but do not paint over the fire rated label so it remains visible after the plywood is installed.



3.03 INSTALLATION

- A. Perform all installation in conformance with ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3, BICSI standards, and the manufacturer's installation guidelines.
 - 1. Provide the Work in accordance with the Contract Drawings, the manufacturer's instructions, and approved Submittals.
 - 2. Clean, adjust, test, and condition the manufactured articles, materials, and equipment, and place them in service in accordance with the manufacturer's directions and recommendations except as otherwise indicated in the Contract Documents.
 - 3. Submit the manufacturer's installation guidelines to the Program/Project manager for information.
- B. Cable Trays:
 - 1. To route bulk telecommunications equipment within the main distribution frame (MDF), provide cable trays.
 - 2. Install cable trays while keeping the proper clearance from HVAC ducting or other obstacles.
 - a. Place cable trays 7 feet 6 inches above the finished floor (AFF), or as otherwise indicated on the Contract Drawings.
 - 3. Ground and bond the cable trays and ladder racking to the telecommunications grounding busbar (TGB) in the communications room.
- C. Free Standing Equipment Cabinets and Racks:
 - 1. Provide free standing equipment racks mounted side by side and secured to adjacent racks in a line-up.
 - a. Connect multiple racks and cabinets together directly or indirectly via vertical cable management hardware as indicated in the Contract Drawings.
 - b. Install the racks so segregated cable management of jumper cross-connects, network patches, and fiber jumpers is provided.
 - c. Maintain a 3-foot working clearance in the front and in the back of each equipment rack, and a 3 foot working clearance at both ends of the equipment rack or multiple rack assemblies.
 - 1) Measure the clearance from the outermost surface of the equipment and connecting hardware rather than from the equipment rack since some of these devices may extend beyond the equipment rack.
 - 2. Mount racks and cabinets to the floor in accordance with the manufacturer's procedures for floor mounting the equipment.
 - a. Submit the manufacturer's procedures for floor mounting the equipment to the Program/Project Manager for information.
 - 3. Run power cables, control cables, and high-level cables for rack mounted equipment on the left side of an equipment rack as viewed from the rear;



run other cables on the right side of the equipment rack as viewed from the rear.

4. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of not less than 3 feet, and ensure that the cable is long enough to allow full extension of the drawer or slide.

3.04 REPAIR/RESTORATION

- A. Replace equipment damaged prior to system acceptance at no increase in the Contract Price.
 1. If damage to the communications equipment room fittings is sustained during implementation of the communication system, provide the additional material and labor necessary to properly rectify the situation in a timely fashion.

3.05 SITE QUALITY CONTROL

- A. Inspections:
 1. At a minimum, the Program/Project Manager, or its designated representative, will perform random and unannounced onsite inspections during the installation to ensure that the communications items are installed in accordance with the Contract Documents and City of Phoenix requirements.
 2. In addition, a final inspection and a complete review of the communications system will be performed in accordance with the requirements specified in Section 16702, Basic Communications Materials and Methods, before the system installation is accepted.
 3. Inspections and testing performed exclusively for the convenience of the Contractor are the sole responsibility of the Contractor.
- B. Non-Conforming Work
 1. Discrepancies noted during field inspections conducted by the Program/Project Manager must be corrected prior to system acceptance.

3.06 SYSTEM STARTUP

- A. Provide system startup as specified in Section 16702, Basic Communications Materials and Methods.

3.07 CLOSEOUT ACTIVITIES

- A. Record Documentation:
 1. The final installation is subject to the Program/Project Manager's approval.
 - a. Prior to the use of any system components, prepare Record Drawings for submission to the Program/Project Manager.



- b. System acceptance will not be provided without complete as-built documentation.
- 2. Record Drawings:
 - a. A complete set of AutoCAD 2000 Contract Drawings will be provided to the Contractor.
 - b. Prepare CAD as-built drawings of the completed layout of each communications room in the structured cabling system (SCS) by entering the information on a separate layer on the set of Contract Drawings provided.
 - 1) Include drawings of all installed equipment within each communications room.
 - c. Submit the as-built drawings Record Drawings to the Program/Project Manager for approval.

3.08 PROTECTION

- A. Protect installed products from damage during construction operations until Final Acceptance.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.





SECTION 16712

COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for providing backbone fiber optic cable and copper cable for communications systems as shown on the Contract Drawings.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16062 - Communications Grounding and Bonding.
 - 4. Section 16076 - Communications Identification.
 - 5. Section 16081 - Communications Testing.
 - 6. Section 16702 - Basic Communications Materials and Methods.
 - 7. Section 16705 - Pathways for Communication Services.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ALVYN: A coated aluminum, polyvinyl chloride (PVC) jacket.
 - 2. ANSI: American National Standards Institute.
 - 3. AWG: American Wire Gauge.
 - 4. CAD: Computer Aided Drafting.
 - 5. ELFEXT: Equal Level Far End Crosstalk.
 - 6. IT: Information technology.
 - 7. NEXT: Near End Crosstalk.
 - 8. OSP: Outside plant.
 - 9. PSELFEXT: Power Sum Equal Level Far End Crosstalk.
 - 10. PVC: Polyvinyl Chloride.
 - 11. SCS: Structured Cabling System.
 - 12. TSB: Technical Systems Bulletin.
- B. Definitions:
 - 1. Backbone: A facility, such as a pathway, cable, or conductors between telecommunications rooms, or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings.
- C. Reference Standards:
 - 1. Building Industry Consulting Services International (BICSI):
 - a. ANSI/NECA/BICSI 568 – Standard, Installing Commercial Building Telecommunications Cabling.
 - b. BICSI TDMM - Telecommunications Distribution Methods Manual.



- c. BICSI OSPDRM – Outside Plant Design Manual.
- d. BICSI ESSDRM – Electronic Safety and Security Reference Manual.
- e. BICSI ITSIM – Information Transport Systems Installation Manual.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department:
 - 1) Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
- 3. Insulated Cable Engineers Association (ICEA):
 - a. ANSI/ICEA S-83-596 – Fiber Optic Premises Distribution Cable.
 - b. ANSI/ICEA S-87-640 - Fiber Optic Outside Plant Communications Cable.
- 4. International Electrotechnical Commission (IEC):
 - a. IEC 60793 – International Standard – Optical Fibres – Part 1-1 Measurement Methods and Test Procedures – General and Guidance.
- 5. InterNational Committee for Information Technology Standards (INCITS):
 - a. ANSI/INCITS 231 – Information Systems – Fibre Distributed Data Interface (FDDI) – Physical Layer Protocol (PHY-2).
- 6. International Standards Organization (ISO):
 - a. ISO 9001 – Quality Management Systems – Requirements.
- 7. International Standards Organization/International Electrotechnical Commission (ISO/IEC):
 - a. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premises.
- 8. National Institute of Standards and Testing (NIST):
 - a. NIST Policy on Traceability.
 - b. NIST Standard Reference Material (SRM).
- 9. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. TIA/EIA-455-B – Standard Test Procedure for Fiber Optic Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.
 - b. TIA/EIA 492 Series – Generic Specification for Optical Waveguide Fibers, and Amendments.
 - c. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - d. ANSI/TIA/EIA-568-B.2 – Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - e. ANSI/TIA/EIA-568-B.3 – Optical Fibre Cabling Components Standard.
- 10. Telecommunications Industry Association (TIA):
 - a. TIA 569-B – Commercial Building Standard for Telecommunications Pathways and Spaces.



- b. TIA 758-A – Customer Owned Outside Plant Telecommunications Infrastructure Standard.
- c. TSB-140 – Additional Guidelines for Field Testing Length, Loss and Polarity of Optical Fibers.
- 11. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
- 12. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
- 13. Underwriters Laboratories, Inc. (UL):
 - a. UL 910 – Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces (*no longer listed*).
 - b. UL 1666 – Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
 - c. UL Performance Verification Service Requirements.
 - d. UL Qualification Tests and Follow-Up Service Requirements.
 - e. UL Product Directories.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate construction meetings as agreed with the Program/Project Manager.
- B. Scheduling:
 - 1. Adhere to the installation schedule approved by the Program/Project Manager.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Multimode fiber optic cable.
 - 2) Singlemode fiber optic cable.
 - 3) Fiber splice modules.
 - 4) Copper cable.
 - 5) Copper cabling protection units.
 - 6) Closures.
 - 7) Fiber patch cords.
 - 8) Fiber optic patch panels.
 - b. Shop Drawings:



- 1) Backbone Cable Layout.
 - 2) Backbone Cable Pulling Plan.
 - 3) General procedures for the installation process.
 - c. Certificates:
 - 1) Termination and Test Equipment Certification.
- B. Closeout Submittals:
 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Warranty Documentation:
 - 1) Manufacturer's guidelines for what constitute warranty liability issues.
 - 2) Special Communications Backbone Cabling Warranty.
 - b. Record Documentation:
 - 1) As-built drawings of the completed communications backbone cabling system.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. Phoenix Building Construction Code:
 - a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.
 2. Install the cabling so it meets all applicable national and local codes pertaining to low voltage cable system installations.
- B. Qualifications:
 1. Manufacturer Qualifications:
 - a. Multi-Mode Fiber Optic Cable Manufacturer: ISO 9001 Certified Manufacturer.
 - b. Single-Mode Fiber Optic Cable Manufacturer: ISO 9001 Certified Manufacturer.
 - c. Copper Cable Manufacturer: ISO 9001 Certified Manufacturer, and providing products complying with the appropriate UL Qualification Tests and Follow-Up Service Requirements.
 2. Structured Cabling System Installer's Qualifications:
 - a. Employ the structured cabling system installer specified in Section 16702, Basic Communications Materials and Methods, for installing the communications horizontal cabling.
- C. Certifications:
 1. Termination and Test Equipment Certification:
 - a. Furnish termination and test equipment calibrated in accordance with the traceability requirements of the National Institute of Standards and Testing (NIST).



- b. Submit a copy of the calibration documents, and certification that the equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver materials in their original packages with their labels intact, and each item clearly identified.
 2. Ship fiber optic and copper cable on reels of the lengths specified, with a minimum overage of 10 percent.
 - a. Wind the cable on the reels so the cable can be unwound without kinking.
 - b. Make 2 meters of cable at both ends of the cable accessible for testing.
 - c. Attach a permanent water resistant label showing the length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture to each reel.
 - 1) Use indelible writing on the labels.
- B. Storage and Handling Requirements:
 1. Store copper cable where the minimum storage temperature range is minus 40 degrees Celsius to plus 70 degrees Celsius.

1.07 WARRANTY

- A. Manufacturer Warranty:
 1. Have the chosen manufacturer prepare and submit written guidelines for what constitutes warranty liability issues regarding moves, adds, and changes to the cable plant performed by the Phoenix Sky Harbor International Airport's personnel to the Program/Project Manager for information.
- B. Special Warranty:
 1. Provide a Special Communications Backbone Cabling Warranty on the materials, services, and adherence of the cabling system to the requirements of this Section for a period of not less than 20 years.
 - a. If items supplied as part of this Contract have longer standard warranties, provide the longer warranty for those items.
 - b. Certify within the warranty that the cabling system supports and conforms to the requirements of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and/or ANSI/TIA/EIA-568-B.3 covering current and future applications, which support transmission over a properly constructed horizontal cabling system premises network.
 - c. Cover the replacement or repair of defective products, and the labor for the replacement or repair of such defective products.



2. Submit the Special Communications Backbone Cabling Warranty to the Program/Project Manager for approval.

PART 2 PRODUCTS

2.01 SYSTEMS

- A. Manufacturers:
 1. Manufacturer List:
 - a. Ortronics/Berk Tek, NetClear System,
<http://www.cablinginstall.com/articles/2002/01/ortronics-berk-tek-introduce-cat-6-netclear-system.html>.
 - b. Approved equal.
 2. Substitution Limitations:
 - a. Comply with the substitution requirements specified in Section 16702, Basic Communications Materials and Methods.
 3. Product Options:
 - a. Comply with the product option requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 1) The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not meant to preclude other manufacturers that may be qualified to provide communications components.
 - 2) Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
 - b. Product Data:
 - 1) Submit manufacturers Product Data for the communication backbone cabling products proposed for the Work of this Section to the Program/Project Manager for approval.
 - c. Provide the standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products.
 - d. Provide the manufacturer's latest standard design which has been in satisfactory use for at least 1 year prior to the award of this Contract.
 - e. For cable, equipment, modules, assemblies, parts, and components of the same classification, provide identical items.
- B. Description:
 1. Regulatory Requirements:
 - a. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work, including among others the following:
 - 1) Phoenix Building Construction Code and Amendments.
 - 2) City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - 3) Aviation Supplement to City of Phoenix Information Technology Standards.



C. Performance:

1. Provide a cabling system that complies with the performance requirements of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 including NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, delay skew, bandwidth, characteristic impedance, attenuation/loss channel, and attenuation to crosstalk ratio (ACR) requirements.
2. Provide materials rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location, including the following:
 - a. Interior Controlled Environment: 64 to 75 degrees Fahrenheit dry bulb and 30 to 55 percent relative humidity, non-condensing.
 - b. Interior Uncontrolled Environment: 0 to 130 degrees Fahrenheit dry bulb and 10 to 95 percent relative humidity, non-condensing.
 - c. Exterior Environments: Minus 30 degrees to 130 degrees Fahrenheit dry bulb, and 10 to 100 percent relative humidity, condensing.
 - d. Hazardous Environment: Rate and install system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings, according to Chapter 5 of the NFPA 70 and as shown on the Contract Drawings.

D. Design Criteria:

1. Provide the materials as described herein and shown on the Contract Drawings, and provide the cabling necessary to interconnect all system equipment, including equipment located in Telecommunications Rooms.
 - a. Comply with the requirements specified in Section 16702, Basic Communications Materials and Methods.
 - b. Perform the calculations and analysis to support design and engineering decisions.
 - c. Perform calculations and record the actual values for cable run pulling tensions, and submit the calculations and recorded values to the Program/Project Manager for approval.
2. Cable in Air Handling and Ventilation Spaces:
 - a. For cable placed in a space used as an air return or in any way connected with air handling plenums or building ventilation, provide low-smoke, fire retarding cable complying with Articles 725, 760, and 800 of NFPA 70 (National Electrical Code).
 - 1) Do not place cabling in plenums without the written approval of the Program/Project Manager.
 - b. For cable installed in plenums or air-handling spaces, provide cable that complies with the requirements of UL 910, and that is marked "OFNP" in accordance with NFPA 70, the National Electrical Code.
3. To support voice, data, and building service applications, provide copper riser cable.



4. For voice grade wire and cable placed in the outside environment, provide solid, twisted pair, and multi-conductor cabling.
 - a. For copper twisted pairs, provide cabling having a mutual capacitance at 1kHz of 15.7 nF/1000 feet.
5. Underground Copper Cable:
 - a. For underground copper cable, including cable installed in conduits or duct banks, provide cable that contains an additional moisture barrier in the form of a flooding compound.
6. Fiber Optic Cable:
 - a. Provide fiber optic cable certified to comply with all parts of TIA/EIA-455-B, and to comply with the applicable requirements of NFPA 70, the National Electrical Code.
 - 1) Provide the appropriate sheath for the particular fiber optic cable application in accordance with ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and/or ANSI/TIA/EIA-568-B.3.
 - b. Riser Cable:
 - 1) For riser cable, provide cable that complies with the requirements of UL 1666, and that is marked "OFNR" in accordance with NFPA 70, the National Electrical Code.
 - c. Building Cables:
 - 1) Nonplenum Rated Cable:
 - a) Provide nonplenum rated riser cable that consists of multiple fibers having a non-filled ribbon structure with a nonmetallic crossply polyvinyl chloride (PVC) core tube and a PVC outer jacket.
 - b) Provide UL-listed nonplenum rated riser cable that complies with the NFPA 70 requirements for type "OFNR" cable.
 - 2) Plenum Rated Cable:
 - a) Provide plenum rated cable that consists of multiple fibers organized into subunits, each fiber subunit surrounded with a color-coded low smoke polyvinyl chloride (PVC) buffer tube and reinforced with aramid yarn for extra strength, and the whole having a plenum polyvinyl chloride (PVC) outer jacket.
 - b) Provide UL-listed nonplenum rated riser cable and subunits that comply with the NFPA 70 requirements for type "OFNP" cable.
 - d. Fiber Optic Patch Cords:
 - 1) Provide manufactured duplex type fiber optic patch cords supplied from the same manufacturer as the termination hardware and cable to insure compatibility and performance.
 - 2) Do not field-fabricate patch cords unless doing so is unavoidable.
 - 3) Provide a quantity of multimode and singlemode patch cords of the appropriate length for the particular application, and equal to the number of ports on all patch panels.



- 4) Appropriately dress slack in the patch cords using vertical and horizontal patch cord organizers to maintain a neat appearance.
- e. Fiber Optic Cable Color Codes:
 - 1) Provide optical fiber conductors that follow standard color code schemes.
 - 2) Provide fiber numbers and binders corresponding to the color codes indicated in Table 16712-1:

Table 16712-1 Color Codes for Fiber Numbers and Binders			
Fiber/Binder Number	Color	Fiber/Binder Number	Color
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Slate	11	Rose
6	White	12	Aqua

7. Shop Drawings:
 - a. Prior to beginning to pull cable, prepare and submit Shop Drawings to the Program/Project Manager indicating the intended Backbone Cable Layout and Backbone Cable Pulling Plan and the general procedures for the installation process.
 - 1) Include the number of cables per run, the outlet configurations, and other pertinent data.
 - 2) Identify pulling point locations.
 - 3) Identify pulling tensions.
 - 4) List of the termination and test equipment to be used to perform the Work.
8. Conflicts
 - a. If conflicts between referenced requirements arise, comply with the one establishing the more stringent requirements.
 - b. If conflicts between referenced requirements and the Contract Documents arise, comply with the one establishing the more stringent requirements.

E. Materials:

1. Multimode Fiber Optic Cable:
 - a. Provide UL-listed multimode fiber optic cable having fibers that comply with TIA/EIA 492 series of standards, ANSI/ICEA S-83-596, and ANSI/ICEA S-87-640.



- b. Provide multimode fibers having dual wavelength capability transmitting at 850nm and 1300nm ranges, and rated for use as riser cabling.
- c. Provide multimode fiber optic cable having a mechanically strippable coating.
- d. For multimode riser rated and multi-mode plenum rated indoor cabling, provide orange colored sheaths.
- e. Provide multimode fiber optic cable that meets or exceed the requirements in Table 16712-2.

Table 16712-2 Multimode Fiber Optic Cable Properties	
Property	Requirement
Core Diameter	62.5µm plus or minus 3.0µm
Core Non-Circularity	Less than 6 percent
Core/Cladding Concentricity Error	Less than 3.0µm
Numerical Aperture	0.275 plus or minus 0.015
Cladding diameter	125.0µm plus or minus 2.0µm
Cladding Non-Circularity	Less than 2 percent
Coating	250µm plus or minus 15µm
Buffering Diameter	900 mm plus or minus 50 mm
Minimum Tensile Strength	100,000 psi
Cable Minimum Bending Radius During Installation: After Installation:	20 times the cable diameter 10 times the cable diameter
Operating Temp. Range	-40°F to 185°F (-40°C to 77°C)
Storage Temp. Range	-40°F to 185°F (-40°C to 77°C)
Maximum Fiber Loss	3.5 dB/km at 850 NM 1.0 dB/km at 1300 NM
Minimum Bandwidth	850nm: 200 MHz at 1km 1300nm: 500 MHz at 1km
Gigabit Ethernet Distance Guarantee	300 meters at 850nm, 550 meters at 1300nm
Attenuation Uniformity	There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm

**Table 16712-2 Multimode Fiber Optic Cable Properties**

Property	Requirement
Attenuation Macro bend	Attenuation due to 100 turns of fiber around a 75mm plus or minus 2mm diameter mandrel exceeding 0.5 dB at 850nm is unacceptable
Attenuation at the Water Peak	Attenuation coefficient at 1380nm exceeding the attenuation coefficient at 1300nm by more than 1.0 dB/km is unacceptable

2. Singlemode Fiber Optic Cable:
- Provide UL-listed singlemode fiber optic cable having fibers that comply with TIA/EIA 492 series of standards, ANSI/ICEA S-83-596, and ANSI/ICEA S-87-640.
 - Provide fibers complying with TIA/EIA-455-B and the IEC 60793 test methods for the required attributes.
 - Provide fibers having dual wavelength capability transmitting at 1310nm and 1550nm ranges, and rated for use as riser cabling.
 - Provide singlemode fiber optic cable having a mechanically strippable coating.
 - For singlemode riser rated and single-mode plenum rated cabling, provide yellow colored sheaths.
 - Provide singlemode fiber optic cable that meets or exceed the requirements in Table 16712-3.

Table 16712-3 Singlemode Fiber Optic Cable Properties

Property	Requirement
Core Diameter	8.3 μm
Cladding Diameter	125.0 μm plus or minus 1.0 μm
Cladding Non-Circularity	Less than or equal to 1.0 percent
Index of Refraction	0.37 Percent
Core/Cladding Concentricity	Less than or equal to 0.8 μm
Coating Diameter	250 μm plus or minus 15 μm
Mode Field Diameter	8.8 μm plus or minus 0.5 μm at 1310 nm



Table 16712-3 Singlemode Fiber Optic Cable Properties	
Property	Requirement
Minimum Proof Strength	100,000 psi
Cable Minimum Bending Radius During Installation: After Installation:	20 times cable diameter 10 times cable diameter
Operating Temp. Range	-40°F to 170°F (-40°C to 77°C)
Storage Temp. Range	-40°F to 170°F (-40°C to 77°C)
Maximum Fiber Loss Depressed Clad	0.4 dB/km at 1310 nm 0.3 dB/km at 1550 nm
Gigabit Ethernet Distance Guarantee	5000 meters at 1310 nm and 1550nm
Maximum Dispersion	2.8 ps/nm-km 1285 to 1330 nm
Fiber Cutoff Wavelength	≥1130 nm. ≥1300 nm
Fiber Macrobend (100 turns @ 32 nm diameter)	≥0.05 dB at 1310 nm ≥0.10 dB at 1550 nm
Coating Strip Force	$1.3N \leq F \leq 8.9N$

3. Fiber Splice Modules:
 - a. Fiber splicing and closures:
 - 1) Unless specifically approved otherwise by the Program/Project Manager's IT Representative, provide fusion splices.
 - 2) Provide fiber splice modules complying with the following requirements:
 - a) Mechanical Requirements:
 - (1) Capable of joining single mode and multimode fibers.
 - (2) Capable of establishing a permanent mechanical splice.
 - (3) May be used in outside plant and/or premises applications.
 - (4) Accepts 250 and 900 micron fibers.
 - (5) Re-enterable, re-arrangeable, and reusable.
 - (6) Requires no polishing.
 - (7) Requires no adhesives.
 - (8) Has no loose parts.
 - (9) Has 1 part index matching gel.
 - (10) Has unlimited shelf life.
 - b) Optical Requirements:
 - (1) Splice Loss: Less than 0.20 dB
 - (2) Reflection: Less than 50 dB



- (3) Stability: Stable from - 40 degrees Fahrenheit to 185 degrees Fahrenheit (- 40 degrees Celsius to 85 degrees Celsius).
4. Copper Cable:
- a. Provide copper cable having the appropriate sheath for the particular application in accordance with the requirements of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and/or ANSI/TIA/EIA-568-B.3.
 - b. Copper Riser Cable – Inside Plant:
 - 1) Unless specified otherwise, provide multi-pair riser cable for all riser cabling.
 - a) For vertical riser cables, provide shielded or unshielded 24 AWG multi-pair copper cables.
 - b) Unless the cables are placed in conduit or if specified otherwise, provide plenum rated multi-pair copper cables.
 - c) Conformance test 25 to 300 pair cables to verify they comply with the requirements for Category 3 cables specified in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3.
 - 2) Shielded Nonplenum Cable:
 - a) Provide shielded nonplenum cable consisting of solid-copper conductors insulated with expanded polyethylene covered by a PVC skin.
 - (1) Provide the shielded nonplenum cable with an outer jacket of polyvinyl chloride (PVC) plastic to form an ALVYN sheath having improved frictional properties which allow the cable to be pulled through conduit without the use of lubricants.
 - (2) Overlay the core with a corrugated aluminum sheath adhesively bonded to ALVYN sheath.
 - b) Provide cable available in 25, 50, 100, 150, 200, and 300 pair counts.
 - c) Provide shielded nonplenum cable UL® Listed as “CMR”.
 - d) Provide shielded nonplenum cable that meets or exceeds the electrical characteristics listed in Table 16712-4, Table 16712-5, and Table 16712-6.

Table 16712-4 Shielded Nonplenum Cable Electrical Characteristics	
Characteristic	Acceptable Value
Average DC Resistance, maximum	26.5Ω/1,000 feet (8.7Ω/100m)
Average DC Resistance Unbalance, maximum	1.7 percent



Mutual Capacitance at 1kHz, maximum	16 nF/1000 feet (5.25 nF/100 m)
Capacitance Unbalance, maximum (pair to ground)	201pF/1,000 feet (65.94 pF/100m)

Table 16712-5 Shielded Nonplenum Cable Attenuation [dB/100m (328 ft.)]	
Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

Table 16712-6 Shielded Nonplenum Cable Worst Pair Near-End Crosstalk (NEXT) [dB/100m (328 ft)]	
Frequency	Pair-To-Pair NEXT (Max.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

- 3) Non-Shielded Nonplenum Cable:
- a) Provide non-shielded nonplenum cable consisting of solid-copper 24 AWG conductors insulated with color coded PVC.
 - b) Provide cable available in 25, 50, 75, and 100 pair counts.
 - (1) For 25 pair cable, in addition to the conformance testing specified herein for non-shielded nonplenum cable provide cable UL[®] Verified to ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3 requirements for Category 3 cables.
 - c) Provide non-shielded nonplenum cable that meets or exceeds the electrical characteristics listed in Table 16712-7, Table 16712-8, and Table 16712-9.

**Table 16712-7 Non-Shielded Nonplenum Cable
Electrical Characteristics**

Characteristic	Acceptable Value
Maximum DC Resistance	28.6 Ω /1,000 feet (9.4 Ω /100m)
Maximum DC Resistance Unbalanced	5 percent
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 feet (328 pF/m)
Mutual Capacitance at 1kHz, maximum	18 nF/1000 feet (5.9 nF/100 m)

**Table 16712-8 Non-Shielded Nonplenum Cable
Attenuation [dB/100m (328 ft.)]**

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

**Table 16712-9 Non-Shielded Nonplenum Cable
Worst Pair Near-End Crosstalk (NEXT) [dB/100m (328 ft)]**

Frequency	Pair-To-Pair NEXT (Max.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

- c. Copper Cable – Outside Plant:
- 1) For voice grade wire and cable placed in the outside environment, provide solid, twisted pair, and multi-conductor cabling.
 - a) For copper twisted pairs, provide cabling having a mutual capacitance of 15.7 nF/1000 feet at 1kHz.
 - 2) Provide cables conformance tested to verify they comply with the requirements for Category 3 cables specified in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3.
 - 3) Multi-Pair Copper Cable:



- a) Provide multi-pair copper cable that meets or exceeds the electrical characteristics listed in Table 16712-10, Table 16712-11, and Table 16712-12.

Table 16712-10 Multi-Pair Copper Cable Physical Characteristics	
Characteristic	Value(s)
Gauge	24 AWG
Pair Size	25 to 300

Table 16712-11 Multi-Pair Copper Cable Electrical Characteristics	
Characteristic	Acceptable Value
DC Resistance, maximum	27.3 Ω /1000 feet (8.96 Ω /100m)
Mutual Capacitance at 1kHz, maximum	15.7 nF/1000 feet (5.15 nF/100m) (25 pair),
Impedance	100 Ω (25 pair)

Table 16712-12 Buried/Underground Cable Attenuation (db/1,000 ft [305m])	
Frequency	Acceptable Value
772 kHz	5.6 (25 pair), maximum
1.0 MHz	6.4 (25 pair), maximum

5. Copper Cabling Protection Units:
- a. For copper circuits between each building, provide entrance cable protector panels to protect the circuits.
 - 1) Route building-to-building circuits through this protector.
 - 2) Provide solid state plug-in protector modules for each pair terminated on the chassis of the protector panels.
 - b. Provide a 6 AWG copper bonding conductor to connect the protector ground lug to the telecommunications ground point.
6. Closures:
- a. Re-Enterable Closure:
 - 1) Provide 50-pair, 100-pair, and 300-pair re-enterable closure as required.
 - 2) Manufacturers:
 - a) 3m, http://solutions.3m.com/en_US



- (1) 50-pair, 3M No. 3924.
 - (2) 100-pair, 3M No. 3925.
 - (3) 300-pair, 3M No. 3926.
 - b) Approved equal.
- b. Buried Closures:
 - 1) Provide 2-inch, 3-inch, 4-inch, 5-inch, 7-inch, and 9-inch better buried closures as required.
 - 2) Manufacturers:
 - a) 3m, http://solutions.3m.com/en_US
 - (1) 2-inch, 3M No. 2BB/SC.
 - (2) 3-inch, 3M No. 3BB/SC.
 - (3) 4-inch, 3M No. 4BB/SC.
 - (4) 5-inch, 3M No. 5BB/SC.
 - (5) 7-inch, 3M No. 7BB/SC.
 - (6) 9-inch, 3M No. 9BB/SC.
 - b) Approved equal.
- c. Encapsulant:
 - 1) Provide encapsulant.
 - 2) Manufacturers:
 - a) 3m, 4441, http://solutions.3m.com/en_US
 - (1) 600 grams, 3M No. BB2-12/GEL.
 - (2) 1200 grams, 3M No. BB2-24/GEL.
 - (3) 3000 grams, 3M No. BB3-24/GEL.
 - (4) 4500 grams, 3M No. BB4-24/GEL.
 - (5) 7200 grams, 3M No. BB5-26/GEL.
 - b) Approved equal.
- 7. Fiber Patch Cords:
 - a. Multimode Fiber Patch Cords:
 - 1) Provide multimode fiber patch cords consisting of buffered, graded-index fiber with a 62.5 micron core with 3.0mm cordage and 125 micron cladding.
 - a) Cover the fiber cladding with aramid yarn and a jacket of flame-retardant polyvinyl chloride (PVC).
 - 2) Terminate multimode fiber patch cords with ST connectors.
 - 3) Provide multimode fiber patch cords that meet or exceed the requirements listed in Table 16712-13.

Table 16712-13 Multimode Fiber Patch Cord Requirements

Parameter	Requirement
Mated Connector Loss	$\mu = 0.3 \text{ dB}$, $\sigma = 0.2 \text{ dB}$
Operating temperature	-4° to 158° F (-20 to 70° C)
Cable Retention	50 pounds (220 N), minimum

**Table 16712-13 Multimode Fiber Patch Cord Requirements**

Parameter	Requirement
Connection Repeatability	0.20 dB maximum change per 100 reconnects
Operating temperature	-4° to 158° F (-20 to 70° C)

b. Singlemode Fiber Patch Cords:

- 1) Provide singlemode fiber patch cords consisting of a stepped-index 8.3 micron core with 3.0mm cordage and 125 micron cladding.
 - a) Cover the fiber cladding with aramid yarn and a jacket of flame-retardant polyvinyl chloride (PVC).
- 2) Terminate singlemode fiber patch cords with SC connectors.
- 3) Provide singlemode fiber patch cords that meet or exceed the requirements listed in Table 16712-14.

Table 16712-14 Singlemode Fiber Patch Cord Requirements

Parameter	Requirement
Return Loss	-50 dB maximum
Operating temperature	-4 degrees Fahrenheit to 158 degrees Fahrenheit (-20 degrees Celsius to 70 degrees Celsius)
Mated connector loss	$\mu = 0.35 \text{ dB}$, $\sigma = 0.2 \text{ dB}$
Cable Retention	50 pounds (220 N), minimum
Connection Repeatability	0.20 dB maximum change per 200 reconnects

8. Fiber Optic Patch Panels:

- a. Preload the multimode connector panels with Duplex 568ST (OSP and Riser) adapters.
 - 1) Provide beige connectors for multimode connector panels.
- b. Preload the singlemode connector panels with Duplex 568SC (OSP and Riser) adapters.
 - 1) Provide blue connectors for singlemode connector panels.
- c. Configure the fiber distribution cabinets with jumper troughs to aid in jumper management.
- d. Fiber distribution cabinets must be rack-mounted in either welded steel equipment racks or enclosed data cabinets, and must include radiused fiber patch cord management.



2.02 ACCESSORIES

- A. Labels:
 - 1. Provide labels for communications backbone cabling that comply with the requirements specified in Section 16076, Communications Identification.
- B. Communications Pathways:
 - 1. Provide communications pathways complying with the requirements specified in Section 16705, Pathways for Communication Services.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify that the main telecommunications grounding system is properly installed and has been tested in accordance with the requirements of Section 16062, Communications Grounding and Bonding.
 - 2. Verify that the communications conduit, raceways, and boxes are properly installed in accordance with the recommended practices of BICSI (ANSI/NECA/BICSI 568, BICSI TDMM, BICSI OSPDRM, BICSI ESSDRM, and BICSI ITSIM) and ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3.
 - a. Verify that the conduit has a minimum diameter of 1 inch.

3.02 INSTALLATION

- A. Install backbone cabling so that a fully operational, tested, certified, and warranted cabling system is provided.
 - 1. Install backbone cabling in accordance with the requirements of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, ANSI/TIA/EIA-568-B.3, BICSI installation guidelines (ANSI/NECA/BICSI 568, BICSI TDMM, BICSI OSPDRM, BICSI ESSDRM, and BICSI ITSIM), and the Contract Drawings, manufacturer's instructions, and approved Submittal data
- B. Install the components of the cabling system in a neat, professional manner.
 - 1. Strictly observe wiring color codes.
 - 2. Provide uniform terminations throughout the installation.
 - 3. Neatly dress the cables at the termination points.
- C. Unless otherwise specified, install fiber optic cables in innerduct throughout the entire length of the cable run.
 - 1. Terminate these fibers in the communications rooms using ST or SC type connectors in wall or rack mounted fiber optic distribution shelves equipped with a sufficient number of panels, couplers, and jumper storage shelves to terminate and secure the fibers.



- D. Extend riser and tie cables between communications rooms using interfloor conduit sleeves.
- E. Ensure that the maximum pulling tensions of the specified distribution cables are not exceeded, and the cable bends maintain the proper radius during the placement of the facilities.
 - 1. Maintain the proper bend radii throughout the entire length of each cabling run, and at all termination locations.
 - 2. Observe the bending radius and pulling strength requirements of all backbone cables during handling and installation.
- F. Provide service loops (slack) for cables terminating in the main equipment room or the telecommunications rooms.
 - 1. Unless specified otherwise, provide a 6-foot service loop above the access ceiling or cable trays
- G. Rack Mounted Equipment:
 - 1. For rack mounted equipment, run power cables, control cables, and high-level cables on the left side of the equipment rack as viewed from the rear.
 - a. Run other cables on the right side of an equipment rack as viewed from the rear.
 - 2. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of not less than 3 feet, and ensure that the cable is long enough to allow full extension of the drawer or slide.
- H. Cable Ties:
 - 1. Bundle the cables by providing Velcro wraps of the appropriate length.
 - 2. Install Velcro ties so the cables may be easily removed or added to the cable bundle.
 - 3. Do not use plastic cable ties at any location within this Contract.

3.03 REPAIR/RESTORATION

- A. Replace materials damaged prior to system acceptance at no cost increase in Contract Price.
 - 1. If damage to the cables is sustained during the implementation, provide the additional material and labor necessary to properly rectify the situation in a timely fashion.

3.04 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Site Tests:
 - a. Have the testing and verification specified performed by a third party in accordance with the requirements specified in Section 16081, Communications Testing.



- b. Have all of the communications testing performed witnessed by the Program/Project Manager.
- 2. Inspections:
 - a. Inspections and testing performed exclusively for the convenience of the Contractor are the sole responsibility of the Contractor.

B. Non-Conforming Work

- 1. If the appropriate guidelines are not followed, provide the additional material and labor necessary to properly rectify the situation in a timely fashion.

C. Manufacturer Services:

- 1. Require the system vendors to coordinate, test, and problem solve the installation.

3.05 SYSTEM STARTUP

- A. Provide system startup as specified in Section 16702, Basic Communications Materials and Methods.

3.06 CLOSEOUT ACTIVITIES

A. Record Documentation:

- 1. The final installation is subject to the Program/Project Manager's approval.
 - a. Prior to the use of any system components, prepare Record Drawings and cable inventory data documentation for submission to the Program/Project Manager.
 - b. System acceptance will not be provided without complete as-built documentation.
- 2. Record Drawings:
 - a. A complete set of AutoCAD 2000 Contract Drawings will be provided to the Contractor.
 - b. Prepare CAD as-built drawings of the completed communications backbone cabling system part of the structured cabling system (SCS) by entering the cable information on a separate layer on the set of Contract Drawings provided.
 - 1) Prepare as-built documentation of the entire backbone cable installation as part of the structured cabling system (SCS), including the following:
 - a) A complete diagram of the terminations in the Telecommunications Rooms.
 - b) A complete diagram of the copper and fiber cable.
 - c) A complete diagram of the copper inter-building cable.
 - d) Floor plans showing exact cable routings.
 - e) A complete diagram of the cable tray, conduits, and conduit sleeves.



- 2) Include cable numbers.
 - 3) Follow the format and labeling conventions specified in Section 16076, Communications Identification.
 - 4) Place all of the requested drawings on the set of Contract Drawings so the cable routes are to scale, and provide accurate information for use in the future when changes are made and the exact location of cables are required to avoid service interruptions.
 - c. Submit the as-built drawings Record Drawings to the Program/Project Manager for approval.
 3. Cable Inventory Data Documentation:
 - a. Submit cable inventory data, for all fiber and copper cabling and termination equipment provided, to the Program/Project Manager for information; and include the following information for each item:
 - 1) Manufacturer's name.
 - 2) Manufacturer's part numbers and com code numbers.
 - 3) Cable numbers utilizing the Phoenix Sky Harbor International Airport cable numbering standard as specified in 16076, Communications Identification.
 - 4) Include documentation on riser cable and interbuilding cable indicating the cable number, source and destination, type of cable, length of cable, and the number of pairs or fibers.
 - 5) Complete cross connect documentation is required.
 - 6) Include detailed documentation of every pair of copper risers and inter-building cable, and every fiber of the fiber optic cables.
 - b. Prepare cable inventory data documentation in a format approved by the Program/Project Manager, so the data can be incorporated into cable management system databases.
 - c. Submit the cable inventory data documentation to the Program/Project Manager for approval.
- B. Training:
1. Furnish PSHIA personnel with adequate training in the processes involved for moves, additions, and changes to the cable plant.

3.07 PROTECTION

- A. Protect installed products from damage during construction operations until Final Acceptance.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 16714

COMMUNICATIONS CONNECTING CORDS, DEVICES, AND ADAPTORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for the communications connecting cords, devices, and adaptors to be used for supporting telecommunications and other special systems.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01780 - Closeout Submittals.
 - 3. Section 16062 - Telecommunications Grounding and Bonding.
 - 4. Section 16702 - Basic Communications Materials and Methods.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ATM: Asynchronous Transfer Mode.
 - 2. AWG: American Wire Gauge.
 - 3. CAD: Computer Aided Drafting.
 - 4. ELFEXT: Equal Level Far End Crosstalk.
 - 5. IDF: Intermediate Distribution Frame.
 - 6. NEXT: Near End Crosstalk.
 - 7. Mbps: Megabits per second.
 - 8. OSP: Outside plant.
 - 9. PVC: Polyvinyl Chloride.
 - 10. SCS: Structured cabling system.
 - 11. TMGB: Telecommunications Main Grounding Busbar.
 - 12. UTP: Unshielded twisted pair.
- B. Definitions:
 - 1. Multimode Optical Fiber: An optical fiber that carries many paths of light.
 - 2. Singlemode Optical Fiber: An optical fiber that carries only one path of light.
- C. Reference Standards:
 - 1. Building Industry Consulting Services International (BICSI):
 - a. ANSI/NECA/BICSI 568 – Standard, Installing Commercial Building Telecommunications Cabling.
 - b. BICSI TDMM - Telecommunications Distribution Methods Manual.
 - c. BICSI OSPDRM – Outside Plant Design Manual.
 - d. BICSI ESSDRM – Electronic Safety and Security Reference Manual.



- e. BICSI ITSIM – Information Transport Systems Installation Manual.
- 2. City of Phoenix (COP):
 - a. Phoenix Building Construction Code and Amendments.
 - b. City of Phoenix Aviation Department:
 - 1) Premises Distribution System Standards Report.
 - 2) Aviation Supplement to City of Phoenix Information Technology Standards.
- 3. International Standards Organization (ISO):
 - a. ISO 9001 – Quality Management Systems – Requirements.
- 4. Phoenix Sky Harbor International Airport (PSHIA):
 - a. PSHIA Premises Distribution System Standards:
 - 1) PSHIA Communication Network and Infrastructure Systems Design.
- 5. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
 - a. ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - b. ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA-568-B.3 – Optical Fiber Cabling Components Standard.
- 6. Underwriters Laboratories, Inc. (UL):
 - a. UL Qualification Tests and Follow-Up Service Requirements.
 - b. UL Product Directories.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate all communications work with the Program/Project Manager and the approved Contract schedule.
 - a. Give required notices for items affecting the Contract schedule.
- B. Pre-Installation Meetings:
 - 1. The communications equipment Subcontractor must attend all construction meetings related to the communication equipment installation scheduled by the Contractor.
- C. Scheduling:
 - 1. Make every effort to schedule the Work of this Section so disruption of public areas during installation is limited.
 - 2. Adhere to the installation schedule approved by the Program/Project Manager.

1.04 SUBMITTALS

- A. Action Submittals:



1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Product Data:

- 1) Patch panels and modular patch panels.
- 2) Optical fiber panels.
- 3) Fiber splicing and closures.
- 4) Splice closure.
- 5) Termination blocks.
- 6) Copper patch cords.
- 7) Multimode fiber patch cords.
- 8) Singlemode fiber patch cords.
- 9) Building entrance protection blocks.
- 10) Grounding bars.

- b. Qualification Statements:

- 1) Communications connecting cord, device, and adaptor manufacturers' qualifications.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:

- a. Manufacturer's Instructions:

- 1) Manufacturer's installation guidelines.

C. Closeout Submittals:

1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:

- a. Warranty Documentation:

- 1) Manufacturer's standard warranties.

- b. Record Documentation:

- 1) Record Drawings of the connecting devices and adaptors.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

1. Phoenix Building Construction Code:

- a. Perform the Work of this Section in accordance with requirements of the Phoenix Building Construction Code and Amendments.

B. Qualifications:

1. Manufacturer Qualifications:

- a. Multi-Mode Fiber Optic Cable Manufacturer: ISO 9001 Certified Manufacturer.

- b. Single-Mode Fiber Optic Cable Manufacturer: ISO 9001 Certified Manufacturer.



- c. Communications Connecting Cord, Device, and Adaptor
Manufacturer's Qualifications:
 - 1) Obtain communications connecting cords, devices, and adaptors from experienced manufacturers who have been regularly engaged in the production of telecommunications equipment room fittings of the types to be installed under this Contract for a minimum period of 5 years.
 - 2) Submit the communications connecting cord, device, and adaptor manufacturers' qualifications to the Program/Project Manager for approval.
- 2. Structured Cabling System Installer's Qualifications:
 - a. Employ the structured cabling system installer specified in Section 16702, Basic Communications Materials and Methods, for installing the communications connecting cords, devices, and adaptors.
- C. Certifications:
 - 1. Underwriters Laboratory, Inc. Certifications:
 - a. Provide singlemode and multimode fiber patch cords, cross connect panels, and termination blocks complying with the appropriate UL Qualification Tests and Follow-Up Service Requirements.

1.06 WARRANTY

- A. Manufacturer Warranty:
 - 1. Provide the manufacturer's standard warranty for the products provided under this Section.
 - a. Include 110 wiring blocks in manufactures channel performance requirements and warranty program.
 - 2. Submit the warranty to the Program/Project Manager.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Substitution Limitations:
 - a. Comply with the substitution requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 2. Product Options:
 - a. Comply with the product option requirements specified in Section 16702, Basic Communications Materials and Methods.
 - 1) The manufacturers and specific part numbers listed in this Section are provided as an aid in the construction process and are not meant to preclude other manufacturers that may be qualified to provide communications components.



- 2) Other manufacturers with comparable qualifications may be proposed but are subject to review as an approved equal.
- 3) Submit documentation for the components proposed to be installed under this Contract as required.

B. Description:

1. Regulatory Requirements:

- a. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities, which bear on performance of the Work of this Section, including among others the following:
 - 1) Phoenix Building Construction Code and Amendments.
 - 2) City of Phoenix Aviation Department Premises Distribution System Standards Report.
 - 3) Aviation Supplement to City of Phoenix Information Technology Standards.

C. Design Criteria:

1. Provide the materials as described herein and shown on the Contract Drawings, and provide the connecting cords, devices, and adaptors necessary to interconnect all system equipment, including equipment located in Telecommunications Rooms.
 - a. Comply with the requirements specified in Section 16702, Basic Communications Materials and Methods.
2. Should there be any discrepancies or a question of intent, refer the matter to the Program/Project Manager for a decision before ordering any equipment and materials, and before starting any related work.
3. Conflicts:
 - a. If conflicts between referenced requirements arise, comply with the one establishing the more stringent requirements.
 - b. If conflicts between referenced requirements and the Contract Documents arise, comply with the one establishing the more stringent requirements.

D. Materials:

1. Patch Panels and Associated Components:

- a. Patch Panels:
 - 1) Provide patch panels having a termination block capable of supporting the appropriate Category 6 applications, including 100 Base-T, 52/155 Mbps ATM, and 1000 BASE-T Gigabit Ethernet; and of facilitating cross connection and inter connection using modular patch cords.
 - a) Wire modular jack panels to T568B.
 - b) Provide patch panels having a wiring block capable of accommodating 24 AWG cable conductors.



- 2) Provide only modular cross connect panels that are UL-listed in accordance with the UL Qualification Tests and Follow-Up Service Requirements.
- 3) Patch Panel Specifications:
 - a) Provide patch panels with electrical characteristics that meet or exceed those listed in Table 16711-2.

Table 16711-2 Patch Panel Electrical Characteristics						
Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT	Return Loss
0.772	1.6	76.0	74.0	70.0	67.0	N/A
1	1.8	74.3	72.3	67.8	64.8	20
4	3.6	65.3	63.3	55.7	52.7	23
8	5.1	60.8	58.8	49.7	46.7	24.5
10	5.8	59.3	57.3	47.8	44.8	25
16	7.3	56.3	54.3	43.7	40.7	25
20	8.2	54.8	52.8	41.7	38.7	25
25	9.2	53.3	51.3	39.8	36.8	24
31.25	10.4	51.9	49.9	37.9	34.9	24
62.5	15.0	47.4	45.4	31.8	28.8	22
100	19.3	44.3	42.3	27.8	24.8	20
200	28.3	39.8	37.8	21.7	18.7	18
250	32.1	38.3	36.3	19.8	16.8	17
300	35.6	37.2	35.2	18.2	15.2	17
350	38.9	36.2	34.2	16.9	13.9	16
400	42.0	35.3	33.3	15.7	12.7	16
450	45.0	34.5	32.5	14.7	11.7	16
500	47.9	33.8	31.8	13.8	10.8	15
550	50.6	33.2	31.2	12.9	9.9	15

- b. Modular Patch Panels:
 - 1) Provide modular patch panels where specified.



2. Optical Fiber Panels:
 - a. Fiber Optic Distribution System:
 - 1) Fiber Optic Interconnect Units and Distribution Shelves:
 - a) Provide a modular enclosure designed and suitable for fiber optic interconnection, cross-connection, and splicing applications of outside plant (OSP) cables.
 - b) Provide rack-mounted fiber optic termination cabinets/terminals in either welded steel equipment racks or enclosed data cabinets.
 - (1) Provide rack-mounted distribution shelves consisting of a modular enclosure with front and rear access that can be fully administered from the front or rear.
 - (2) Provide distribution shelves that fit into a 19-inch frame arrangement, and provide terminating capability for 24, 48, 72, or 144 fibers.
 - 2) The manufacturer of the fiber optic interconnect units and distribution shelves must be ISO 9001 certified.
 - b. Fiber Splicing and Closures:
 - 1) Unless otherwise approved by the Program/Project Manager, provide only fusion splices.
 - 2) Provide fiber splice modules that have the following required mechanical features:
 - a) Join singlemode and multimode fibers.
 - b) Establish a permanent mechanical splice.
 - c) May be used in outside plant and/or premises applications.
 - d) Accept 250 and 900 micron fibers.
 - e) Re-enterable, re-arrangeable, and reusable.
 - f) Require no polishing.
 - g) Require no adhesives.
 - h) Contain no loose parts.
 - i) Use a one-part index matching gel.
 - j) Have unlimited shelf life.
 - 3) Provide fiber splice modules that have the following required optical features:
 - a) Splice Loss: Less than 0.20 dB.
 - b) Reflection: Less than 50 dB.
 - c) Stable from -40 degrees Fahrenheit to 185 degrees Fahrenheit (-40 degrees Celsius to 85 degrees Celsius).
 - 4) All underground manholes shall be provided with 100' slack coiled neatly and properly labeled and limited to one splice enclosure.
3. Splice Closure:
 - a. Provide fiber splice closures capable of sealing, bonding, anchoring, and protecting fiber optic cable splices in aerial, underground, and direct buried applications.
 - b. Provide a standalone closure that does not require an outer closure.



- c. Provide fiber splice closures capable of accommodating a maximum of 6 cable entries in a butt-end configuration.
- 4. Termination Blocks:
 - a. Wiring Blocks:
 - 1) Provide wiring blocks complying with the EIA/TIA Category 6 requirements.
 - 2) Provide disconnect type 110 wiring blocks for the termination of horizontal, equipment, or tie cables; and of a high-density modular design compatible with all voice and data circuits provided under this Contract.
 - a) Provide fire retardant, molded plastic wiring blocks consisting of horizontal index strips for field-terminating 25 pairs of conductors each.
 - (1) Mark the index strips with 5 colors on the high teeth, separating the tip and ring of each pair, to establish pair location.
 - b) Locate a series of fanning strips on each side of the block for dressing the cable pairs terminated on the adjacent index strips.
 - 3) Provide wiring blocks capable of accommodating 22 AWG through 26 AWG conductors.
 - 4) Provide wiring blocks that are available in 25, 50, 100, and 300 pair sizes.
 - a) Provide 100 and 300 pair wiring blocks that are available with or without legs that allow the cables to pass behind the wiring block and fan out to each side.
 - b) Ensure that the space created by the feet on each side of the block can be used as a vertical jumper trough.
 - c) Because wiring blocks having 25 and 50 pair sizes are not available with legs, use them only for low pair count and/or depth restrictive situations.
 - d) Height:
 - (1) For 25- and 50-pair wiring blocks: 1.75 inches (4.45cm).
 - (2) For 100-pair wiring blocks: 3.59 inches (9.12cm).
 - (3) For 300-pair wiring blocks: 10.79 inches (27.41cm).
 - 5) Provide wiring blocks capable of accommodating over 500 repeated insertions without incurring permanent deformation, and having no more than one contact failure in 10000 connections.
 - 6) Provide wiring blocks capable of being mounted directly on wall surfaces with backboards, or on a 24-inch free-standing frame.
 - b. Label Holders:
 - 1) Provide clear label holders with the appropriate colored inserts with the wiring blocks that do not interfere with running, tracing, or removing jumper wire/patch cords; and insert labels containing vertical lines spaced on the basis of circuit size (3-, 4-, or 5-pair).



- c. Provide only termination blocks that are UL-listed in accordance with the UL Qualification Tests and Follow-Up Service Requirements.
- d. Manufacturers:
 - 1) Systimax, www.commscope.com/systtmax/.
 - 2) Ortronics, www.ortoniics.com.
 - 3) Siemon, www.siemon.com.
 - 4) Approved equal.
- 5. Patch Cords:
 - a. Copper Patch Cords:
 - 1) For each port on the patch panel, provide factory-made, round Category 6 modular patch cords complying with the requirements specified in the Horizontal Cabling Sections of ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3; and consisting of 24 AWG copper, stranded conductors, tightly twisted into individual pairs.
 - a) Provide patch cords that are backward compatible with Category 5/5e systems.
 - 2) To insure compatibility and the highest system performance levels, provide patch cords manufactured by the same manufacturer as the termination (patch panels and jack modules) hardware.
 - 3) Equip the cords with an 8-pin modular connector on each end.
 - b. Provide copper patch cords that meet or exceed the Guaranteed Channel Performance Specifications listed in Table 16711-3.

Table 16711-3 Copper Patch Cords Guaranteed Channel Performance Specifications								
Frequency	Insertion Loss (dB)	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT (dB)	Return Loss (dB)	Phase Delay (ns)	Delay Skew (ns)
1	2.1	72.7	70.3	63.2	60.2	19.0	580	30
4	4.0	63.0	60.6	51.2	48.2	19.0	562	30
8	5.7	58.2	55.6	45.2	42.2	19.0	557	30
10	6.3	56.6	54.0	43.2	40.2	19.0	555	30
16	8.0	53.2	50.6	39.1	36.1	19.0	553	30
20	9.0	51.6	49.0	37.2	34.2	19.0	552	30
25	10.1	50.0	47.4	35.3	32.3	18.0	551	30
31.25	11.4	48.4	45.7	33.3	30.3	17.1	550	30
62.5	16.4	43.4	40.6	27.3	24.3	14.1	549	30



Table 16711-3 Copper Patch Cords Guaranteed Channel Performance Specifications								
Frequency	Insertion Loss (dB)	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT (dB)	Return Loss (dB)	Phase Delay (ns)	Delay Skew (ns)
100	21.1	39.9	37.1	23.2	20.2	12.0	548	30
125	23.8	38.3	35.4	21.3	18.3	11.0	547	30
155.5	27.9	36.7	33.8	19.4	16.4	10.1	547	30
175	28.7	35.8	32.9	18.4	15.4	9.6	547	30
200	30.9	34.8	31.9	17.2	14.2	9.0	547	30
250**	35.0	33.1	30.2	15.3	12.3	8.0	546	30

- c. Unless specified otherwise, provide copper patch cords of the length(s) specified or detailed in the Contract Drawings.
- 1) Provide unshielded twisted pair (UTP) patch cord lengths as indicated in Table 16711-4 for the location or application.

Table 16711-4 Copper Patch Cords UTP Patch Cord Lengths	
Length	Location/Application
3 feet	From the patch panel to the electronic equipment located within the equipment rack, cabinet, or backboard
5 feet	From the patch panel to the electronic equipment located within the equipment rack, cabinet, or backboard
7 feet	From the patch panel to the electronic equipment located within the equipment rack, cabinet or backboard and from the jack to the computer workstation
9 feet	From the Jack to the computer workstation
15 feet	From the Jack to the computer workstation

- d. Fiber Patch Cords:
- 1) Multimode Fiber Patch Cords:
 - a) Provide UL-listed factory-made multimode fiber patch cords consisting of buffered, graded-index fiber having a 62.5 micron core with 3.0mm cordage and a 125 micron cladding.
 - (1) Cover the fiber cladding with aramid yarn and a jacket of flame-retardant polyvinyl chloride (PVC).
 - b) Provide multimode patch cords that meet or exceed the electrical characteristics listed Table 16711-5:

**Table 16711-5 Multimode Patch Cord
Electrical Characteristics**

Parameter	Requirement
Operating temperature	-4 degrees Fahrenheit to 158 degrees Fahrenheit (-20 degrees Celsius to 70 degrees Celsius)
Mated Connector Loss	$\mu = 0.3$ dB, $\sigma = 0.2$ dB
Cable Retention	50 lb. (220 N) minimum
Connection Repeatability	0.20 dB maximum change per 100 reconnects

2) Singlemode Fiber Patch Cords:

- a) Provide UL-listed factory-made singlemode fiber patch cords consisting of a stepped-index 8.3-micron core with 3.0mm cordage and 125 micron cladding.
 - (1) Cover the fiber cladding with aramid yarn and a jacket of flame-retardant polyvinyl chloride (PVC).
 - (2) Provide singlemode fiber patch cords that meet or exceed the requirements listed in Table 16711-14.

Table 16712-6 Singlemode Fiber Patch Cord Requirements

Parameter	Requirement
Return Loss	-50 dB maximum
Operating temperature	-4 degrees Fahrenheit to 158 degrees Fahrenheit (-20 degrees Celsius to 70 degrees Celsius)
Mated connector loss	$\mu = 0.35$ dB, $\sigma = 0.2$ dB
Cable Retention	50 pounds (220 N), minimum
Connection Repeatability	0.20 dB maximum change per 200 reconnects

6. Building Entrance Protection Blocks:

- a. Provide building entrance protection blocks equipped with solid-state protector modules, and full and lockable covers.
- b. Provide building entrance protection blocks equipped with a splice chamber and factory installed 710 type splice modules on the in-side (field side), and 110 type termination on the out-side (equipment).
- c. Manufacturers:
 - 1) Systimax (Commscope), www.commscope.com/systimax/.
 - 2) Circa, www.circatel.com.
 - 3) Tii Technologies, <http://www.tiitech.com/>.
 - 4) Approved equal.



2.02 ACCESSORIES

- A. Grounding Bars:
 - 1. Telecommunications Main Grounding Busbar (TMGB):
 - a. Provide a telecommunications main grounding busbar (TMGB) as specified in Section 16062, Telecommunications Grounding and Bonding.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Grounding:
 - a. Verify that the main telecommunications grounding system is properly installed and has been tested in accordance with the requirements of Section 16062, Communications Grounding and Bonding.
 - 2. Pathway Installation:
 - a. Verify that the communications conduit, raceways, and boxes are properly installed in accordance with the recommended practices of BICSI (ANSI/NECA/BICSI 568, BICSI TDM, BICSI OSPDRM, BICSI ESSDRM, and BICSI ITSIM), ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3; and the PSHIA Premises Distribution System Standards.
 - b. Verify that the conduit has a minimum diameter of 1 inch.

3.02 INSTALLATION

- A. Perform all installation in conformance with ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, and ANSI/TIA/EIA-568-B.3, BICSI standards, and the manufacturer's installation guidelines.
 - 1. Provide the Work in accordance with the Contract Drawings, the manufacturer's instructions, and approved Submittals.
 - 2. Clean, adjust, test, and condition the manufactured articles, materials, and equipment, and place them in service in accordance with the manufacturer's directions and recommendations except as otherwise indicated in the Contract Documents.
 - 3. Submit the manufacturer's installation guidelines to the Program/Project manager for information.
- B. Building Entrance Protection Blocks:
 - 1. Terminate outside plant copper cables entering the building on wall-mounted building entrance protection block equipment.
 - 2. Terminate copper cables up to and including 100 pair on protection blocks.



3. For each protection block installed, provide a separate cross-connect point by providing a separate 110 type termination block adjacent to the protection block, and install and terminate an indoor rated copper cable, pair to pair.

C. Patch Cords:

1. Provide the number of copper patch cords equal to the number of ports on the patch panels of the appropriate length for the particular application
2. Provide multimode and singlemode fiber patch cords of the appropriate length for the particular application indicated in the Contract Documents.
3. Appropriately dress the slack in the patch cords using vertical and horizontal patch cord organizers to maintain a neat appearance.

D. Patch Panels:

1. Provide modular patch panels capable of housing both fiber and Category 6 copper terminations simultaneously for the ceiling mounted intermediate distribution frames (IDF).

E. Cable Ties:

1. Bundled cables using Velcro wraps of the appropriate length, and so cables may be easily removed or added to the cable bundle.
2. Do not use plastic cable ties at any location for the Work of this Contract.

3.03 REPAIR/RESTORATION

- A. Replace equipment damaged prior to system acceptance at no increase in the Contract Price.

3.04 SITE QUALITY CONTROL

A. Inspections:

1. At a minimum, the Program/Project Manager, or its designated representative, will perform random and unannounced onsite inspections during the installation to ensure that the communications items are installed in accordance with the Contract Documents and City of Phoenix requirements.
2. In addition, a final inspection and a complete review of the communications system will be performed in accordance with the requirements specified in Section 16702, Basic Communications Materials and Methods, before the system installation is accepted.
3. Inspections and testing performed exclusively for the convenience of the Contractor are the sole responsibility of the Contractor.

B. Non-Conforming Work

1. Discrepancies noted during field inspections conducted by the Program/Project Manager must be corrected prior to system acceptance.



3.05 SYSTEM STARTUP

- A. Provide system startup as specified in Section 16702, Basic Communications Materials and Methods.

3.06 CLOSEOUT ACTIVITIES

- A. Record Documentation:
 - 1. The final installation is subject to the Program/Project Manager's approval.
 - a. Prior to the use of any system components, prepare Record Drawings for submission to the Program/Project Manager.
 - b. System acceptance will not be provided without complete as-built documentation.
 - 2. Record Drawings:
 - a. A complete set of AutoCAD 2015 Contract Drawings will be provided to the Contractor.
 - b. Prepare CAD as-built drawings of the connecting devices and adaptors in the structured cabling system (SCS) by entering the information on a separate layer on the set of Contract Drawings provided.
 - c. Submit the as-built drawings Record Drawings to the Program/Project Manager for approval.

3.07 PROTECTION

- A. Protect installed products from damage during construction operations until Final Acceptance.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/13/2017	N/A	All	First edition.



SECTION 16735

PASSENGER EMERGENCY DURESS SYSTEM (PEDS)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for a passenger emergency duress system (PEDS) that include the following components:
 - a. Emergency and customer assistance call station devices.
 - b. Remote diagnostic and reporting software.
 - c. Computer work station and monitor.
 - 2. Requirement for completing the Passenger Emergency Duress System Compliance Matrix, attached to the end of this Section, and certifying compliance with each requirement specified.
- B. Related Requirements:
 - 1. Section 01316 - Project Meetings.
 - 2. Section 01325 - Progress Schedules and Reports.
 - 3. Section 01330 - Submittal Procedures.
 - 4. Section 01360 - Sustainable Design Requirements.
 - 5. Section 01732 - Cutting and Patching.
 - 6. Section 01770 - Closeout Procedures.
 - 7. Section 01780 - Closeout Submittals.
 - 8. Section 01810 - Commissioning.
 - 9. Section 16995 - Commissioning of Electrical Systems.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. AVI: Audio video interweave.
 - 2. AWG: American Wire Gauge.
 - 3. CCTV: Closed circuit television.
 - 4. CD: Compact disc.
 - 5. CD-RW: Compact Disc-Rewritable.
 - 6. CO: Central office.
 - 7. CPU: Central processing unit.
 - 8. DVD: Digital video disc.
 - 9. CPU: Central processing unit.
 - 10. DDR2: Double data rate.
 - 11. DIMM: Dual in-line memory module.
 - 12. ECC: Error correction code.
 - 13. FBS: Front-side bus, the bus that carries data between a personal computer's central processing unit (CPU) and the north bridge.



14. IDF: Intermediate Distribution Frame.
15. KSU: Key service unit.
16. LED: Light emitting diode.
17. MDF: Main Distribution Frame.
18. NBD: Next business day.
19. NTFS: New Technology File System, the standard file system on Microsoft Windows NT, including its later versions Windows 2000, Windows XP, Windows Server 2003, Windows server 2008, Windows Vista, and Windows 7.
20. PBX: Private branch exchange.
21. PBX/CO: Private branch exchange/central office.
22. PDA: Personal digital assistant.
23. PEDS: Passenger emergency duress system.
24. POTS: Plain old telephone service.
25. MDF: Main Distribution Frame.
26. MTBF: Mean time between failure.
27. SATA: Serial advanced technology attachment.
28. SDRAM: Synchronous dynamic random-access memory, which is dynamic random-access memory (DRAM) that has a synchronous interface.
29. TGB: Telecommunications grounding busbar.
30. TMGB: Telecommunications main grounding busbar.
31. USB: Universal serial bus.
32. VOX: Voice Operated Exchange, a voice operated switch that operates when sound over a certain threshold is detected.

B. Reference Standards:

1. ASTM International (ASTM):
 - a. ASTM B 3 - Standard Specification for Soft or Annealed Copper Wire.
 - b. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - c. ASTM B 33 - Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
2. Telecommunications Industry Association (TIA):
 - a. ANSI/TIA-968-B – Telecommunications – Telephone Terminal Equipment – Technical Requirements for Connection to Terminal Equipment to the Telephone Network.
 - b. ANSI/TIA J-STD 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
3. United States Government:
 - a. Department of Justice:
 - 1) 28 CFR 36 Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities.
 - b. Federal Communications Commission (FCC):
 - 1) 47 CFR 15 Radio Frequency Devices.
 - c. Office of the Secretary of Transportation:



- 1) 49 CFR 37 Transportation Services for Individuals with Disabilities (ADA).
- d. Parks, Forests, and Public Property:
 - 1) 36 CFR 1192 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- e. United States Code (U.S.C.):
 - 1) 42 U.S.C. Section 4151 et seq.
 - a) Architectural Barriers Act, Public Law 90-480.
 - 2) 42 U.S.C. Section 12101 et seq.
 - a) Americans with Disabilities Act (ADA), Public Law 101-336.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the delivery and installation of the passenger emergency duress system equipment with the Program/Project Manager.
 - a. Coordinate installation of the call station devices with the Program/Project Manager.
- 2. 10 days before call stations are to be installed, give notice to those performing other construction work related to the call station installation, such as to those performing work that must be supported by or that will provide support of the call stations, to allow such items to be introduced or furnished before the call stations are installed.

B. Pre-Installation Meetings:

- 1. Contract Planning Meeting:
 - a. The Contractor's project manager and key staff must participate in a Contract planning meeting in accordance with the requirements specified in Section 01316, Project Meetings, as required by the Program/Project Manager and the Phoenix Sky Harbor International Airport.
 - 1) The purpose of the session is to ensure proper coordination between the parties responsible for the successful completion of the Work of this Contract.
 - 2) Allow 8 hours for the planning session.
 - b. The Program/Project Manager will coordinate and facilitate the Contract planning session.
- 2. Contract Status Meetings:
 - a. To discuss the status of the installation of the passenger emergency duress system, the Contractor's project manager must attend weekly and monthly Contract status meetings with the Program/Project Manager held in accordance with the requirements specified in Section 01316, Project Meetings.

C. Scheduling:



1. Within 15 calendar days after execution of the Notice to Proceed, develop a Contract schedule for maintaining the real time status of the installation phases in accordance with the requirements specified in Section 01325, Progress Schedules and Reports, including coordination issues with required Phoenix Sky Harbor International Airport activities; and submit the project schedule to the Program/Project Manager for approval.
 - a. The Contract schedule must include major milestones and the critical path.
 - b. The Contract schedule must address order-to-ship time.
 - c. Each week during the course of the Contract, submit a 2-week rolling schedule to be used as the basis for discussion of Contract progress during the weekly installation meetings.
 - 1) In the 2-week rolling schedule, represent the actual detailed work plan to be used to meet the schedule and Contract milestones.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Product Data:
 - 1) Passenger emergency duress system (PEDS).
 - 2) Grounding conductors.
 - 3) Grounding connectors.
 - 4) Names of mounting hardware Suppliers, and mounting hardware Suppliers' part numbers of the relevant parts for various mounting configurations.
 - b. Shop Drawings:
 - 1) Passenger emergency duress system (PEDS).
 - c. Special Procedure Submittals:
 - 1) Compliance Matrix.

B. Informational Submittals:

1. Submit the following to the Program/Project Manager for information in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Manufacturer's Instructions:
 - 1) Passenger emergency duress system (PEDS) component manufacturers' written instructions for handling and storing their products.
 - b. Site Quality Control Submittals:
 - 1) Test report for each test.

C. Closeout Submittals:



1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Operation and Maintenance Data:
 - 1) Operation and Maintenance Manuals for the passenger emergency duress system (PEDS).
 - b. Record Documentation:
 - 1) Record Drawing documents and as-built Shop Drawings.
 - c. Software:
 - 1) Backup copies of the remote diagnostic and reporting software.

1.05 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 1. The Phoenix Sky Harbor International Airport will review and approve all test results and Contract closure requirements.
 2. Testing and Inspection Agencies:
 - a. To perform additional testing and inspections, the Phoenix Sky Harbor International Airport may employ an independent Testing and Inspection Agency.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Deliver passenger emergency duress system (PEDS) components in a clean, undamaged condition.
 2. Inspect passenger emergency duress system (PEDS) components for signs of damage prior to accepting delivery of those items at the Site; and reject, segregate, and remove damaged items.
- B. Storage and Handling Requirements:
 1. Submit the passenger emergency duress system (PEDS) component manufacturers' written instructions for handling and storing their products to the Project/Project Manager for information.
 2. Handle passenger emergency duress system (PEDS) components in accordance with their manufacturer's written instructions.
 3. Follow the manufacturer's written instructions for storing the passenger emergency duress system (PEDS) components.
- C. Packaging Waste Management:
 1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

- A. Existing Products:



1. Computer Workstation and Monitor:
 - a. A Dell OptiPlex GX280 Small Form Factor Chassis desktop computer workstation and monitor will be furnished by the Phoenix Sky Harbor International Airport for uploading and running the diagnostic and reporting software provided under this Section.
 - b. The computer workstation and monitor furnished by the Phoenix Sky Harbor International Airport will have the following minimum features:
 - 1) Processor:
 - a) The computer will have a 3.00 Gigahertz Intel Pentium 4 processor having a front-side bus speed of 800 Megahertz
 - 2) Operating System:
 - a) The computer will have a Microsoft Windows XP Professional operating system with Service Pack 3 (SP3), Media, and the New Technology File System (NTFS) installed.
 - 3) Hyperthreading:
 - a) The computer will have the Hyper-Threading feature preset to "OFF".
 - 4) Memory:
 - a) The computer will have two 400MHz dual in-line memory modules (DIMM) that together provide a 1.0 Gigabyte (GB) double data rate (DDR2) non- error correction code (non-ECC) synchronous dynamic random-access memory (SDRAM).
 - 5) Monitor:
 - a) A Dell Ultrasharp 1901FP flat panel monitor with a height adjustable stand will be provided for the computer workstation.
 - 6) Video Card:
 - a) The computer will have an Integrated DVMT Video card installed.
 - 7) Boot Hard Drives:
 - a) The computer will have an 80 Gigabyte (GB), serial advanced technology attachment (SATA), 7200 revolutions per minute hard drive with a data burst cache.
 - b) The computer will have no floppy drive unless required by the Project.
 - 8) Removable Media Storage Device:
 - a) A removable 24X CDRW/DVD combination media storage device having a DVD playback feature will be provided for the computer workstation.
 - 9) Keyboard:
 - a) A Dell universal serial bus (USB) keyboard having no hot keys will be provided for the computer workstation.
 - 10) Mouse:



- a) A Dell universal serial bus (USB) 2-button optical mouse having the scroll feature will be provided for the computer workstation.
- 11) Speakers:
 - a) An integrated Dell business audio speaker will be provided for the computer workstation.
- 12) Energy Star Setting:
 - a) The computer's Energy Star setting will be enabled.
- 13) Resources Compact Disk (CD):
 - a) A resources compact disk (CD) containing diagnostics and drivers for the OptiPlex small desktop computer workstation and monitor will be provided for the computer workstation.
- 14) Hardware Support Services:
 - a) The computer will have a 4-year limited warranty plus a 4-year next business day (NBD) on-site service agreement.
- 15) Installation Support Services:
 - a) Installation support services for the computer workstation and monitor will not be provided.
- 2. Laser Printer:
 - a. A Hewlett Packard Laser Jet 2300dn black and white laser printer will be furnished by the Phoenix Sky Harbor International Airport for reporting functions of the passenger emergency duress system (PEDS) provided under this Section.

2.02 PASSENGER EMERGENCY DURESS SYSTEM COMPONENTS

- A. Manufacturers:
 - 1. Manufacturer List:
 - a. Subject to compliance with the requirements specified herein, provide products manufactured by one of the manufacturers listed.
 - 2. Substitution Limitations:
 - a. Subject to compliance with the requirements specified, products approved by the Program/Project Manager from manufacturers other than those listed herein may be provided.
 - 3. Product Options:
 - a. If required, have the passenger emergency duress system (PEDS) Supplier submit the names of mounting hardware Suppliers that are capable of furnishing mounting hardware compatible with the passenger emergency duress system (PEDS) Supplier's products, and submit the mounting hardware Suppliers' part numbers of the relevant parts for various mounting configurations, such as wall-mounted and floor-mounted to the Program/Project Manager for approval.
- B. Description:
 - 1. Passenger Emergency Duress System (PEDS):



- a. The intended purpose of the passenger emergency duress system (PEDS) is to provide a means for the public using the Phoenix Sky Harbor International Airport to contact the Airport's staff in the event of an emergency or of a need to request customer assistance.
 - 1) The Phoenix Sky Harbor International Airport is responsible for furnishing a computer and monitor, a laser printer, and a display monitor for displaying the camera call, for use in association with the Work provided under this Section.
 - a) The Phoenix Sky Harbor International Airport is responsible for furnishing space for the computer workstation and monitor.
 - 2) The Phoenix Sky Harbor International Airport is responsible for providing conduit, cabling, and cable terminations for the computer and monitor, laser printer, and display monitor they will furnish for use in association with the Work provided under this Section.
- b. The hardware and software to be provided under this Section are components of the passenger emergency duress system (PEDS) being implemented under the direction of the Phoenix Sky Harbor International Airport.
 - 1) Passenger emergency duress system (PEDS) equipment to be provided under this Section includes wall mounted call stations, free standing call stations, and remote diagnostic and reporting software as specified herein.
 - a) Install the remote diagnostic and reporting software on the computer workstation and monitor furnished by the Phoenix Sky Harbor International Airport.
 - 2) Provide additional related components to work in conjunction with the call stations, such as brackets and other mounting devices to connect them in a non-obstructive way, patch cords to allow connection to power and communication outlets, and patch cords to allow connection to existing closed circuit television (CCTV) cameras.
- c. Phoenix Sky Harbor International Airport Responsibilities:
 - 1) Implementation of the following passenger emergency duress system (PEDS) functions is the responsibility of the Phoenix Sky Harbor International Airport:
 - a) Upon activation of a closed circuit television (CCTV) camera by a call from a call station, automatically displaying the video display of the camera on the monitor selected, and displaying the location information of the call station at the bottom of the monitor.
 - (1) If more than one call station is activated, multiple monitors will be used, and/or split screen features will be activated.
 - b) Archiving the video of the activated cameras' images until the activating phone call is completed.



- c) Upon activation of a call station emergency or customer assistance button, sending location information through the existing phone switch, and displaying the location information on the operator phones.
- 2. Regulatory Requirements:
 - a. Accessibility and American with Disabilities Act (ADA) Requirements:
 - 1) Provide call stations that at a minimum comply with the requirements for two-way communications specified in section 708 of the American with Disabilities Act (ADA) Accessibility Guideline, and with the following additional criteria:
 - a) Provide call stations that are highly visible and easily identifiable to the traveling public, and where possible that have 360 degree visibility.
 - b) Wherever possible for wall mounted or pole mounted call stations, provide call stations that do not extend more than 4 inches from the wall or pole.
 - (1) If call stations do extend more than 4 inches from the wall or pole, then take one or the other of the following measures to ensure that these call stations are not obstructions:
 - (a) Mount the bottom of the call station 27 inches or less from finished floor level; or
 - (b) Mount an obstruction block below the call station so the obstruction can be identified by the use of a cane.
 - c) Mount the operating functions of the call stations no higher than 48 inches and no lower than 15 inches above the finished floor.
 - d) Wherever possible mount the call stations so there is a flat surface in front of and to the side of the units having dimensions 60 inches wide by 60 inches deep, but in no case mount the call stations with a flat surface less than 30 inches wide by 48 inches deep.
 - e) Where the information provided on the call stations is essential to the user, such as “emergency button”, provide Braille on the face of the call station.
 - (1) Where Braille is used, provide raised characters having their long dimension not less than 5/8 inches.
 - f) On each call station, provide a blue light emitting diode (LED) signal light that begins flashing after either the emergency button or customer assistance button is pressed, and that changes to a solid, non-flashing signal light once the call is picked up by the operator.
 - (1) Design the system so the signal light remains on in a non-flashing mode until the call is disconnected.

C. Performance:



1. Call Stations:
 - a. Operating Temperature Range:
 - 1) Provide call stations capable of functioning within the dry bulb temperature range from 0 degrees Fahrenheit to 150 degrees Fahrenheit.
 - b. Operating Humidity Range:
 - 1) Provide call stations capable of functioning within the condensing relative humidity range from 0 percent to 95 percent.
- D. Design Criteria:
 1. Passenger Emergency Duress System (PEDS):
 - a. Provide a passenger emergency duress system (PEDS) that is scalable regarding both the number of call stations and the monitoring software.
 - 1) Monitoring:
 - a) Primary Equipment:
 - (1) Provide a passenger emergency duress system (PEDS) designed to monitor and analyze the following primary components of the call stations for operational status:
 - (a) Auxiliary contacts.
 - (b) Emergency power supply.
 - (c) Strobe light/beacon.
 - (d) Emergency call button.
 - (e) Customer service call button.
 - (f) Speaker/microphone.
 - b) Auxiliary Equipment:
 - (1) Provide a passenger emergency duress system (PEDS) designed to monitor and analyze the following auxiliary components to which the call stations are connected:
 - (a) Surveillance cameras.
 - (b) Phone switches.
 - (c) Power.
 - (d) Strobe/beacon light, including operating conditions.
 - b. Call Stations:
 - 1) At the locations indicated in the Contract Drawings, provide passenger emergency duress system (PEDS) call stations suitable for use in the event of an emergency or a customer assistance related call, and suitable to be mounted on walls, on columns, or in floor-mounted configurations.
 - a) Provide heavy duty, durable, tamper resistant, vandal resistant call stations that are easy to clean.
 - b) Provide passenger emergency duress system (PEDS) call stations capable of 2 way hands free full duplex communications.
 - (1) Provide call stations complying with the requirements specified in 47 CFR 15 and ANSI/TIA-968-B.



- c) Unless otherwise noted, provide call station units that each have the same hardware and are capable of performing the same functions.
 - d) Provide non-proprietary components for the call stations to the greatest extent possible.
 - e) Provide mounting brackets and other mounting components for installation of the call stations.
 - f) Provide other components, parts, and items necessary to make the call station units fully functional.
- 2) Remote Programming:
 - a) Provide passenger emergency duress system (PEDS) call stations capable of having the phone numbers called by the stations, the audible alarm features, and strobe light features, programmed remotely.
- 3) Future Capabilities of the Call Stations:
 - a) Provide call stations that are capable of being equipped in the future with cellular communications and wireless communications.
- c. Computer Workstation and Monitor:
 - 1) To display system-related information, such as remote diagnostic information and reports, a computer workstation and monitor will be provided by the Phoenix Sky Harbor International Airport for uploading the diagnostic and reporting software provided under this Section.
- d. Remote Diagnostics and Reporting Software:
 - 1) Provide remote diagnostic and reporting software designed to have configurable parameters.
 - 2) System Logical Security:
 - a) Because the new audio video interweave (AVI) system will operate in an online real-time open architecture environment, design the software for the AVI system to provide adequate access and password management controls to ensure proper segregation of duties, accountability, and system integrity.
 - (1) Design the software to require both user identification (ID) and a password to identify a specific user's access rights.
 - (2) Design the software to prevent duplicate user identifications (IDs).
 - (3) Design the software to require at least 2 levels of password security for the User and Administration levels.
 - (4) Design the software to lock or suspend users after a specified period of system inactivity.
 - (5) Design the software to have Password Management Controls.
 - 3) Storage:



- a) Provide remote diagnostic and reporting software capable of storing diagnostic information for a preset period of time.
 - (1) Provide software capable of configuring the length of the storage time.
- 4) Outage Alerts:
 - a) Provide remote diagnostic and reporting software capable of alerting the City of Phoenix Aviation Department Communication Center Operator of any outage.
- 5) Polling:
 - a) Automatic Polling:
 - (1) Provide remote diagnostic and reporting software capable of performing automatic polling (self diagnostics) of all call station devices.
 - (2) Provide remote diagnostic and reporting software capable of configuring the frequency of the automatic polling.
 - b) Manual Polling:
 - (1) Provide remote diagnostic and reporting software capable of allowing the City of Phoenix Aviation Department Communication Center Operator to perform manual polling of all call station devices.
 - c) Polling Reports:
 - (1) Provide remote diagnostic and reporting software capable of automatically generating reports for pre-set and manual diagnostic polling, and that specifically identifies any failures.
- 6) Statistical Reports:
 - a) Provide remote diagnostic and reporting software designed to allow the City of Phoenix Aviation Department Communication Center Operator to generate statistical reports of the usage and operability of the call stations.
 - b) Provide remote diagnostic and reporting software designed to allow reports for various statistical information generated over the previous 30 days of use to be produced, including at a minimum the following:
 - (1) Usage trends of the call stations, including emergency and customer assistance calls, by call station device and by area.
 - (2) The duration of the time between activation of the call station, both emergency or customer assistance calls, and phone pickup.
 - (3) Queuing of call station calls.
 - (4) Frequency of failures.
 - (5) Maintenance statistics.
- 7) Ad-Hoc Report Generating Tool:



- a) Provide remote diagnostic and reporting software designed to allow additional reports to be added through an ad-hoc report generating tool.
 - 8) Submit backup copies of the remote diagnostic and reporting software to the Program/Project Manager.
 - e. Communications Network:
 - 1) Use the existing established phone line connections to furnish communications from the computer workstation to each call station so no additional communications network is required.
 - a) Design the call stations to communicate with the passenger emergency duress system (PEDS) through the existing phone line connections.
 - (1) The Phoenix Sky Harbor International Airport will perform modifications to the existing phone switch and phone switch database required to accommodate the Work of this Section.
 - b) Provide passenger emergency duress system (PEDS) software that does not require an additional data network for communications.
 - 2) The Phoenix Sky Harbor International Airport will perform modifications to the existing closed circuit television (CCTV) camera system to ensure that camera call up is performed once a call station emergency button is activated.
2. Product Data:
- a. Obtain the manufacturers' Product Data for the passenger emergency duress system (PEDS), including the following:
 - 1) Passenger emergency duress system (PEDS) and grounding components.
 - 2) The power consumption for each electrical component proposed, in terms of its startup, steady state, and peak usage.
 - a) Identify which components of the call station are to be powered through the telephone line power (20 milliamperes to 24 milliamperes), and which components require 120-Volt power.
 - b) Indicate the on-hook/off-hook line voltage requirements.
 - c) Specifically indicate if the call station requires a battery to provide power to any of the required components.
 - (1) If a battery is required to provide power to any of the required components, indicate if telephone line power or commercial power is required to charge the battery.
 - 3) The ambient noise thresholds for the voice operated exchange (VOX) activated microphones provided as part of the call stations.
 - 4) A description of how the call station acknowledges the disconnect signal from the B-party release.



- a) Identify what B-party release signals and duration the call station recognizes to prevent line lock-out (dial-tone, reorder tone, or break in loop current).
 - b) Indicate the loop current requirements.
 - 5) Detailed information relating to the expected life of the equipment, including the expected mean time between failure (MTBF) for all components.
 - 6) Detailed information related to which components are monitored through the remote diagnostic system.
 - a) Describe the capabilities of the monitoring equipment connected to the call station and described in this Section, including the operation of the Phoenix Sky Harbor International Airport's existing closed circuit television (CCTV) cameras.
 - b) Include the expected cycle times and central processing unit (CPU) usage required for the monitoring computer to run through an entire diagnostic check of all call stations.
 - 7) Detailed information related to possible installation of the remote diagnostic and reporting software on additional Phoenix Sky Harbor International Airport owned computers.
 - a) Include the required computing specifications, and multi-user capabilities.
 - b) Confirm that the Phoenix Sky Harbor International Airport supplied computer, monitor, and printer are suitable as specified for use by the passenger emergency duress system (PEDS), or specify any additional requirements needed.
 - (1) If necessary, indicate required specifications not included in this Section.
 - 8) The scalability of the number of units and software provided.
 - 9) A clear description of the fit and finish of the call station devices proposed for the Work of this Section.
 - 10) Description of how the number of errors caused by pressing the wrong button will be minimized by ensuring the emergency call button is distinct from the customer service call button.
 - 11) Technical information on how the call station can activate the Phoenix Sky Harbor International Airport's existing closed circuit television (CCTV) cameras.
 - b. Submit the passenger emergency duress system (PEDS) manufacturers' Product Data to the Program/Project Manager for approval.
3. Shop Drawings:
- a. Based on results of the Contractor's Site survey activity, prepare Shop Drawings for the passenger emergency duress system (PEDS) showing the location and type of the call stations to be provided under this Section.



- b. Prepare Shop Drawings showing mounting details for the passenger emergency duress system (PEDS) components.
- c. Submit the passenger emergency duress system (PEDS) Shop Drawings to the Program/Project Manager for approval.

E. Operation Sequences:

- 1. Emergency Button Operation Sequences:
 - a. Pressing the emergency button on a call center must activate the passenger emergency duress system (PEDS), and the following must immediately occur:
 - 1) Pressing the emergency button must override all other actions currently active at that call station.
 - 2) A preprogrammed telephone number from the call center to the Airport's Communication Center must be dialed automatically.
 - a) 2-way, hands free full duplex communications through a speaker system located on the call station must be enabled instantly between the call station and the City of Phoenix Aviation Department Communication Center.
 - 3) Information identifying which call station was activated must be automatically sent to the City of Phoenix Aviation Department Communication Center.
 - 4) The strobe light/beacon and an audible alarm on the call center must be activated.
 - a) Once activated, the strobe light must remain on while the two-way communication is active.
 - 5) A closed circuit television (CCTV) camera must be automatically and simultaneously activated.
 - a) The strobe must not "wash out" the video image.
- 2. Customer Service Button Operation Sequences:
 - a. Pressing the customer service button on a call center must activate the passenger emergency duress system (PEDS), and the following must immediately occur:
 - 1) A preprogrammed telephone number from the call center to the City of Phoenix Aviation Department Communication Center must be dialed automatically.
 - a) 2-way, hands free full duplex communications through a speaker system located on the call station must be enabled instantly between the call station and customer assistance.
 - 2) Information identifying which call station was activated must be automatically sent to the City of Phoenix Aviation Department Communication Center.
- 3. Audible Alarm Operation Sequences:
 - a. Pressing the emergency button on a call center must immediately activate the audible alarm.



- b. Once the City of Phoenix Aviation Department Communication Center Operator has connected the phone call, the audible alarm must be automatically silenced.

F. Components:

1. Call Stations:

- a. Provide wall mounted, column mounted, and/or free standing call stations as indicated on the Contract Drawings, and which are each capable of 2 number dialing of up to 15 digits.
- b. Speaker, Microphone, and Buttons:
 - 1) Provide water and dust resistant speakers, microphones, and buttons.
 - 2) Speakers/Microphones:
 - a) For each call station, provide a hands-free speaker and microphone system located on the call station, and including an automatic adjustment for ambient noise, a remote volume control, and a local volume control.
 - b) Provide call stations capable of allowing the City of Phoenix Aviation Department Communication Center to initiate a silent monitoring mode where the City of Phoenix Aviation Department Communication Center Operator can listen to sounds generated around the call station.
 - 3) Emergency Call Button:
 - a) For each call station, provide red emergency push buttons larger than the customer service buttons; and that when pushed, automatically without the need of picking up a handset dial the City of Phoenix Aviation Department Communication Center, activate a blue strobe light, and activate a brief audible annunciation and an existing closed circuit television (CCTV) camera.
 - (1) Provide emergency buttons that send information notifying the City of Phoenix Aviation Department Communication Center Operator which device is in use.
 - (2) Provide emergency buttons having action distinct from the customer service call buttons, and that are easily identifiable.
 - 4) Customer Service Call Button (Info Button):
 - a) For each call station, provide customer service call buttons that when pushed automatically dial the City of Phoenix Aviation Department Communication Center Operator.
 - (1) Provide customer service call buttons that send directional information notifying the City of Phoenix Aviation Department Communication Center Operator which device is in use.
 - (2) Provide customer service call buttons having action distinct from the emergency call buttons, and that



because of their size and style eliminate the potential for the user to be confused how to activate the emergency call or the information call buttons.

- c. Connections:
 - 1) Private Branch Exchange/Central Office (PBX/CO):
 - a) Provide call stations capable of being connected to a 2-wire analog line from a private branch exchange (PBX), a key service unit (KSU), or a plain old telephone service (POTS) line.
 - b) Provide call stations capable of operating over Category 3, Category 5, or optional fiber optic cable.
 - c) Provide call stations capable of detecting disconnection from the phone switch.
 - 2) Auxiliary Contacts:
 - a) Provide call stations having at least 2 dry contact closures, at least one of which is capable of being used for connection to an existing closed-circuit television (CCTV) camera.
- d. Strobe Light/Beacon:
 - 1) Provide call stations having a combination blue light strobe and beacon that generates approximately 1,000,000 candlepower.
 - a) The strobe lamp or beacon may be a light emitting diode (LED).
 - 2) For the strobe lamp, provide a timer adjustable at thirty (30) second intervals, and capable of setting the length of time the strobe light remains on, even if the duplex communications through the speaker system are closed.
 - 3) The beacon must have the capability of always on illumination.
 - 4) Provide a strobe light capable of being turned off either at the call station, or remotely through means of a protected command.
- e. Audible Alarms:
 - 1) Provide call stations having a piezoelectric audible siren or alarm, voice annunciation, or another audible signal designed to alert those near the call station; and configurable for sound level, voice announcement, or tones.
 - 2) Provide audible alarms capable of having the duration the alarm will sound set.
- f. Electrical Power:
 - 1) Provide call stations requiring no more than a 3-Ampere load for the strobe and beacon.
 - 2) Emergency Power Supply:
 - a) Provide a battery backup power supply capable of providing power for all of the call station's components, including the strobe light/beacon, and of being charged periodically by the limited power provided.



- (1) Provide a battery backup power supply capable of providing standby power for at least 8 hours.
 - g. Signage:
 - 1) Provide highly visible and legible engineering grade vinyl signage for the call stations applied directly over the finish color of the call stations.
 - a) Provide a legend reading “EMERGNCY” that is at least 20 inches long on the sides of the wall-mounted call stations and at least 30 inches long on the sides of the floor-mounted call stations.
 - b) Provide “reflective white” graphic legends.
 - 2) Provide the following faceplates for the call station buttons:
 - a) For the emergency buttons, provide a faceplate having a red “Emergency” legend on a white backfield.
 - b) For the customer service call buttons (Info Buttons), provide a faceplate having a black “Info” legend on a white backfield.
 - c) Silk screen additional information, to be determined at a later date, on the call station.
 - h. Manufacturers:
 - 1) Code Blue Corporation, <http://www.codeblue.com>.
 - a) Basis of Design (Free Standing): CB 5-p Pedestal – Interactive Voice Communication Unit with Deck Mounting kit.
 - b) Basis of Design (Wall Mounted): CB 2-e Pedestal – Interactive Voice Communication Unit
 - 2) Approved equal.
- G. Finishes:
 1. Primer Materials:
 - a. Provide a primer that is compatible with both the substrate and the finish coat.
 2. Finish Materials:
 - a. Provide a polyurethane finish coat that is compatible with the primer, and is graffiti-resistant and resistant to ultraviolet radiation.
 - b. Colors:
 - 1) Provide a “safety blue” finish color for the call stations.
 3. Shop Finishing Methods:
 - a. Apply both the primer and finish coats so they each have a minimum dry film thickness of 2 mils.

2.03 ACCESSORIES

- A. Grounding Conductors:
 1. Provide bare or insulated copper American Wire Gauge (AWG) wire grounding conductors complying with the requirements specified in ASTM B 3, ASTM B 8, and ASTM B 33.



2. For communications systems, provide stranded, insulated copper conductor having a minimum size of 6 AWG, since this will accommodate different code requirements and allow for future changes.
 3. Where single conductor insulated grounding conductors are required, furnish green color (or tape marking) insulation rated for 600 volts.
 4. Manufacturers:
 - a. The Okonite Company, www.okonite.com.
 - b. Anixter, www.anixter.com.
 - c. Continental Cables Company, www.continentalcables.com.pk.
 - d. Pirelli Cable Corporation.
 - e. Superior Essex, www.superioressex.com.
 - f. Approved equal.
- B. Grounding Connectors:
1. Provide zinc plated compression type grounding connectors capable of handling up to 2 wires sized up to 4 AWG, and having a hole sized for one 12-24 mounting screw.
 2. Manufacturers:
 - a. Chatsworth Products, Inc., Part Number 40158-020, <http://www.chatsworth.com>.
 - b. Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. After receiving the Notice to Proceed, conduct a Site survey of the call center locations indicated in the Contract Documents to validate the placement of the call station devices, directional signage, computer, and monitor in accordance with requirements specified.
 - a. Based on the results of this Site survey, recommend the types of call stations to be provided under this Section and their final locations, and update the Record Documentation specified in Paragraph 3.07.B accordingly.
- B. Evaluation and Assessment:
1. Proceed installing the passenger emergency duress system (PEDS) only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions:
1. Protect adjacent areas from damage resulting from installation of the passenger emergency duress system (PEDS).
- B. Surface Preparation:



1. Provide anchorage devices and fasteners where needed to secure the call stations to in-place construction.

C. Demolition/Removal:

1. Perform cutting and patching, if required, as specified in Section 01732, Cutting and Patching.

3.03 INSTALLATION

A. Call Stations:

1. Install the passenger emergency duress system (PEDS) call stations in the Terminal 3 Station at the locations indicated in the Contract Documents.
 - a. Where free standing call stations are shown on the Contract Drawings, mount the units on the floor.
 - b. Where wall-mounted call stations are shown on the Contract Drawings, mount the units on the wall 37 inches above the finished floor.
2. Ensure that the passenger emergency duress system (PEDS) call stations' connections are properly installed in all respects, including, but not limited to, their form, fit, and function.
 - a. The installed call station must satisfy not only the specified location requirements for the call station, but must be fully compliant with the American with Disabilities Act (ADA) requirements specified.
 - b. Coordinate connection of the call stations to the Phoenix Sky Harbor International Airport phone switch with the Phoenix Sky Harbor International Airport.

B. Diagnostic and Reporting Software:

1. Upload and install the software for the remote diagnostic and reporting system provided under this Section onto the computer workstation provided by the Phoenix Sky Harbor International Airport.

C. Special Techniques:

1. Communications Grounding:
 - a. Ground the communications equipment in accordance with the requirements specified in ANSI/TIA J-STD 607.
 - 1) Isolated telecommunications main grounding busbars (TMGB) have been installed by others in the power panels located in each communications Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) room.
 - a) The raceway connections and associated grounding within the room will be provided by others.
 - b. Provide cabinet ground connections using grounding conductors, but do not attach more than 3 cabinets on 1 wire segment connected in series.



- 1) Neatly dress the grounding conductors together within the power trays from the cabinets to the telecommunications main grounding busbar (TMGB) using no crosses grounding conductors.
- 2) Provide grounding connectors for attaching the grounding conductors to the rear of the cabinets where directed by the Program/Project Manager.
- 3) Tightly crimp and secure the grounding lugs at the telecommunications main grounding busbar (TMGB) or telecommunications grounding busbar (TGB).

3.04 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when the passenger emergency duress system (PEDS) is being installed, the Testing and Inspection Agency must perform routine and other testing and inspection of materials.
 - a. Advise the Testing and Inspection Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - 1) The Phoenix Sky Harbor International Airport will coordinate integrated test requirements.
 - b. The Testing and Inspection Agency will perform additional materials testing due to changes in materials requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - c. Failure of the Testing and Inspection Agency to detect defective work will not prevent its rejection later when the defect is discovered, neither does it obligate the Program/Project Manager or Phoenix Sky Harbor International Airport to grant final acceptance of the Work.
2. Test Procedures:
 - a. Prepare test procedures for performing the following testing:
 - 1) Call station tests.
 - 2) System/software tests.
 - 3) Final system tests.
 - b. Prepare the test procedure so that each procedure contains at a minimum the following items:
 - 1) Objective of the test.
 - 2) Functional procedure, including the use of any test equipment.
 - a) Identify test equipment by manufacturer and model;
 - 3) Define the interconnection of test equipment, and the steps of operation.
 - 4) Definition of documentation verification, both interconnections and functionality;
 - 5) Results required for compliance with the specified and expected requirements.



- 6) Traceability matrix referencing specification requirements with specific test procedures.
 - c. Submit the test procedures to the Program/Project Manager for approval.
 3. Test the passenger emergency duress system (PEDS) in accordance with the approved test procedures.
 4. Test Reports:
 - a. Within the 10 days following each test, prepare a test report for each test that certifies the successful or unsuccessful completion of that test.
 - 1) Include the test equipment serial number, calibration date, and calibration certification of test equipment;
 - 2) Record the test results, the test witness's initials or signature, and date the testing was performed.
 - 3) Indicate pass or fail evaluation for the equipment or system tested with comments.
 - b. Submit the test reports to the Program/Project Manager for review and acceptance.
 5. Phase Testing:
 - a. Test Procedure:
 - 1) Installation of the call stations may be phased in to support specific Phoenix Sky Harbor International Airport requirements.
 - a) Phase testing will be used to test specific areas that are completed and ready for use.
 - 2) Prior to starting the test, obtain written permission from the Program/Project Manager to commence the tests.
 - 3) Perform tests that demonstrate the system features and functionality.
 - a) Individually and jointly test the units to ensure they are operating properly.
 - b) As part of phase testing, test all components of the system.
 - b. Acceptance Criteria:
 - 1) Demonstrate that the system is operating properly.
 - 2) Acceptance of the test is at the sole discretion of the Program/Project Manager.
 6. Final Acceptance Test:
 - a. Test Procedure:
 - 1) Prior to starting the Final Acceptance Test, obtain written permission from the Program/Project Manager to commence the tests.
 - 2) Do not begin the Final Acceptance Test until all passenger emergency duress system (PEDS) systems have been installed and jointly tested to ensure they are operating properly.
 - 3) Complete the operational and stress testing of the components and systems/software installed.



- 4) During the first 2 weeks of the Final Acceptance Test, furnish personnel to operate the system 24 hours a day, including during weekends and holidays.
 - 5) Furnish on-call service throughout the remaining duration of the Final Acceptance Test.
 - 6) Monitor all systems during this testing, and coordinate the monitoring with the Program/Project Manager.
 - b. Acceptance Criteria:
 - 1) Demonstrate that the system is operating properly.
 - 2) Acceptance of the test is at the sole discretion of the Program/Project Manager.
 7. Final Endurance Test:
 - a. Test Procedure:
 - 1) Perform the Final Endurance Test for 90 days.
 - 2) Monitor all systems during endurance testing, and coordinate the monitoring with the Program/Project Manager.
 - 3) Start the Final Endurance Test only after the following actions have been completed:
 - a) The Final Acceptance Test has been successfully completed.
 - b) The specified training has been completed.
 - c) Deficiencies discovered by earlier testing have been corrected.
 - d) A written start notification from the Program/Project Manager has been received.
 - 4) Record the test data on forms approved by the Phoenix Sky Harbor International Airport to provide a continuous log of systems performance.
 - b. Acceptance Criteria:
 - 1) Demonstrate that the system is operating properly.
 - 2) Acceptance of the test is at the sole discretion of the Program/Project Manager.
 8. Inspections:
 - a. Ensure that all connections to the call station devices and associated functions are completed properly.
- B. Non-Conforming Work
1. Correct the problems identified during each test phase.
 - a. Before any subsequent testing phase is performed, re-test a percentage of the entire system as determined by the Program/Project Manager.
 - b. Correct the discrepancies or problems discovered during these tests at no increase in Contract Price.

3.05 SYSTEM STARTUP

A. Commissioning:



1. Have the Commissioning Authority (CA) perform the startup and checkout activities listed in Section 01810, Commissioning, and Section 16995, Commissioning of Electrical Systems, for the power quality, security systems, emergency power systems, uninterruptible power supply (UPS) systems, communications systems, and public address/paging work pertinent to the Work of this Section.

3.06 CLEANING

A. Waste Management:

1. Comply with the requirements of the approved Waste Management Plan specified in Section 01360, Sustainable Design Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Training:

1. Train the Owner's maintenance personnel to adjust, operate, and maintain the passenger emergency duress system (PEDS) and related equipment in accordance with the requirements specified in Section 01770, Closeout Procedures.
 - a. The Phoenix Sky Harbor International Airport will provide adequate training facilities for each training session.

B. Record Documentation:

1. The Phoenix Sky Harbor International Airport will provide electronic background drawings to be used to prepare Record Drawing submittals.
2. Legibly mark the Record Drawing documents and as-built Shop Drawings to record the actual passenger emergency duress system (PEDS) installation, including communication conduit, cabling and pathways used, field changes of dimensions and details, changes in details from those indicated on the Contract Drawings, details not on the original Contract Drawings, and the make and model of the actual products installed.
 - a. Base the as-built locations of the call stations on the final installation.
3. 14 days prior to completion of the Final Acceptance Test, submit the Record Drawing documents and as-built Shop Drawings to the Program/Project Manager for review.
 - a. Should additional information or revisions be required, the reviewed documents will be returned to the Contractor for correction and re-submittal to the Program/Project Manager.

3.08 MAINTENANCE

A. Operation and Maintenance Data:

1. Prepare Operation and Maintenance Manuals for the passenger emergency duress system (PEDS).



2. Submit the Operation and Maintenance Manuals for the passenger emergency duress system (PEDS) to the Project/Project Manager.

3.09 ATTACHMENTS

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
 1. Compliance Matrix.

END OF SECTION

Passenger Emergency Duress System Compliance Matrix

The purpose of this document is to provide a common form for the Contractor to respond within its proposal for call station devices, remote diagnostic and reporting software, and associated computer and monitors.

The following is a list of the waiverable technical requirements. The references indicated in the Passenger Emergency Duress System Compliance Matrix Description refer Paragraphs and Subparagraphs within Specification Section 16275, Passenger Emergency Duress System.

Check C1, C2 or NC and include comments as necessary.

C1 – Compliance 1 – Vendor’s current product fully complies.

C2 – Compliance 2 – Vendor’s current product does not have this function but Vendor will ensure functionality is part of the base package. Specify in the comments if there is an additional cost

NC – Not Comply

Comments – Specific characteristics, additional cost, etc.

Item No.	Item	Description	C1	C2	NC	Comments
Call Station Hardware Requirements						
1-1	Call Station Type	Wall-mount unit or free standing unit. Unless otherwise noted, each unit has same hardware and function requirements. [Subparagraphs 2.02.D.1.b.1 and 2.02.D.1.b.1.c]				
1-2	Construction	Heavy duty, tamper resistant, vandal resistant, easy to clean, and durable construction. [Subparagraph 2.02.D.1.b.1.a]				
1-3	Components	Non-Proprietary Components to the best extent possible. [Subparagraph 2.02.D.1.b.1.d]				
1-4	Temperature/ Humidity Range	0 to 150 Degrees F, dry bulb. [Subparagraph 2.02.C.1.a.1] 0 to 95 percent relative humidity, condensing. [Subparagraph 2.02.C.1.b.1]				
1-5	Weather	Water and dust resistant speaker, microphone, and buttons. [Subparagraph 2.02.F.1.b.1]				
1-6	Communications	Two way hands free full duplex communications. [Subparagraph 2.02.D.1.b.1.b]				
1-7	Auxiliary Contacts	Minimum of 2 dry contact closures shall be supplied. At least one shall be used for connection to existing CCTV Camera. [Subparagraph 2.02.F.1.c.2.a]				
1-8	PBX/CO	Capable of connecting to a 2-wire analog line from a Private Branch Exchange (PBX), KSU or POTS line. [Subparagraph 2.02.F.1.c.1.a] Devices must be able to operate over Category				

Item No.	Item	Description	C1	C2	NC	Comments
		3, Category 5 or optional fiber optic cable. [Subparagraph 2.02.F.1.c.1.b]				
1-9	Emergency Power Supply	<p>Battery backup power supply that will be charged by power that may be provided in a limited capacity with the following features. [Subparagraph 2.02.F.1.f.2.a]</p> <ol style="list-style-type: none"> 1. A minimum of 8 hours of standby power shall be available; 2. Shall provide power for all components of the call station including strobe light / beacon. 				
1-10	Strobe Light / Beacon	<p>The call station unit includes a combination blue light strobe and beacon with the following [Subparagraph 2.02.F.1.d.1]:</p> <ol style="list-style-type: none"> 1. Strobe shall generate approximately 1,000,000 candlepower. [Subparagraph 2.02.F.1.d.1] 2. As an option strobe lamp or beacon shall have the capability of being a Light Emitting Diode (LED). [Subparagraph 2.02.F.1.d.1.a] 				
1-11	Emergency Button	<p>Action is distinct from the customer service call and easily identifiable. [Subparagraph 2.02.F.1.b.3.a.2] Action should be by push button, without the need of picking up a handset. Emergency button shall be red in color and larger than the Info Button. [Subparagraph 2.02.F.1.b.3.a]</p>				
1-12	Info Button	<p>Action is distinct from the emergency call button. Size and style of button should take into consideration that the potential of the user being confused as to how to activate the emergency call or the information call is eliminated. [Subparagraph 2.02.F.1.b.4.a.2]</p>				
1-13	Speaker/ microphone	<p>Hands-free speaker and microphone system located on the call station with the following features [Subparagraph 2.02.F.1.b.2.a]:</p> <ol style="list-style-type: none"> 1. Automatic adjustment for ambient noise; 2. Remote volume control; and 3. Local volume control. 				
1-14	Signage	<p>At a minimum, each call station shall be equipped with the following signage legends</p>				

Item No.	Item	Description	C1	C2	NC	Comments
		<p>mounted directly on the station:</p> <ol style="list-style-type: none"> 1. “EMERGNCY” on the sides of the call stations. [Subparagraph 2.02.F.1.g.1.a] 2. “Emergency” on the emergency button faceplate. [Subparagraph 2.02.F.1.g.2.a] 3. “Info” – on the information button. [Subparagraph 2.02.F.1.g.2.b] 4. Silk screening on the call station for additional information to be determined at a later date. [Subparagraph 2.02.F.1.g.2.c] 				
1-15	Finish	Provide a “safety blue” polyurethane finish having at least a 4-mil dry film thickness that is graffiti-resistant and resistant to ultraviolet radiation for the call stations. [Subparagraph 2.02.G]				
Call Station Functionality						
2-1	Communications	Call stations are connected to the City Phone switch and each station has 2 number dialing capability up to 15 digits. [Subparagraph 2.02.F.1.a]				
2-2	Remote Programmable	<p>Call Stations are remote programmable for at least the following [Subparagraph 2.02.D.1.b.2.a]:</p> <ol style="list-style-type: none"> 1. Changing phone numbers called by the stations 2. Audible alarm features 3. Strobe light features 				
2-3	Emergency Button	<p>Upon activation of the PEDS by pushing of the emergency button, the following shall immediately occur [Subparagraph 2.02.E.1.a]:</p> <ol style="list-style-type: none"> 1. Automatic dial of preprogrammed number to the Communication Center; 2. Instant 2 way hands free full duplex communications through a speaker system located on the call station. 3. Information is automatically sent to the Communication Center, identifying which call station was activated. 4. Strobe light activation; 5. Immediate activation of audible alarm; 6. Automatic, simultaneous CCTV camera 				

Item No.	Item	Description	C1	C2	NC	Comments
		activation 7. Pressing the Emergency Button overrides all other actions currently active with the call station.				
2-4	Info Button	Upon activation of the PEDS by pushing of the Information button, the following shall immediately occur [Subparagraph 2.02.E.2.a]: 1. Automatic dial of preprogrammed number to the City of Phoenix Aviation Department Communication Center; 2. Immediate 2 way hands free full duplex communications between call station and customer assistance; 3. Location information is automatically sent to the City of Phoenix Aviation Department Communication Center, identifying which call station was activated.				
2-5	Silent Monitoring mode	Silent monitoring mode can be initiated by the City of Phoenix Aviation Department Communication Center, where the operator can listen in on sounds generated around the call station. [Subparagraph 2.02.F.1.b.2.b]				
2-6	Disconnect Detection	The call station can detect disconnection from the phone switch. [Subparagraph 2.02.F.1.c.1.c]				
2-7	Power	Each station shall require no more than 3 amps maximum load for strobe. [Subparagraph 2.02.F.1.f.1]				
2-8	Strobe Light / Beacon	The call station unit includes a combination blue light strobe and beacon with the following: 1. Upon pressing of the emergency button, the strobe light is activated. [Subparagraph 2.02.E.1.a.4] 2. Once activated, the strobe light shall remain on while the two-way communication is active. [Subparagraph 2.02.E.1.a.4.a] 3. Strobe shall not “wash out” video image. [Subparagraph 2.02.E.1.a.5.a] 4. The beacon shall have the capability of always on illumination. [Subparagraph 2.02.F.1.d.3] 5. Ability to set the length of time in which the strobe light shall remain on even if				

Item No.	Item	Description	C1	C2	NC	Comments
		communications are closed. At a minimum, the timer can be adjusted at thirty (30) second interval. [Subparagraph 2.02.F.1.d.2] 6. The strobe light can be turned off either at the station or remotely through command protected means. [Subparagraph 2.02.F.1.d.4]				
2-9	Audible Alarm	The audible alarm has the following features: 1. Audible alarm is activated immediately upon pressing of the emergency button. [Subparagraph 2.02.E.3.a] 2. Audible alarm is silenced once City of Phoenix Aviation Department Communication Center Operator has connected the phone call. [Subparagraph 2.02.E.3.b] 3. Feature for setting duration of time the alarm will sound. [Subparagraph 2.02.F.1.e.2] 4. Alarm is configurable for sound level, voice announcement, or tones. [Subparagraph 2.02.F.1.e.1] 5. Audible alarm may be piezoelectric siren or alarm, voice annunciation, or other means of audible signal designed to alert those near the call station. [Subparagraph 2.02.F.1.e.1]				
Call Station Accessibility and ADA Requirements						
3-1	Visibility	Call stations shall be highly visible and easily identifiable to the traveling public (360 degree visibility where possible) [Subparagraph 2.02.B.2.a.1.a]				
3-2	Obstructions	Wall mounted or pole mounted call stations should not extend beyond 4" from the wall. If call stations do extend more than 4", then provisions must be made so that this mounting would not be considered an obstruction. [Subparagraph 2.02.B.2.a.1.b] Such provisions may include the following: 1. Bottom of call station must be mounted 27 inches or less from finished floor level				

Item No.	Item	Description	C1	C2	NC	Comments
		[Subparagraph 2.02.B.2.a.1.b.1.a]; or 2. Obstruction block must be mounted below the call station for identification of obstruction by use of a cane. [Subparagraph 2.02.B.2.a.1.b.1.b]				
3-3	Height	Operating functions of the call stations must be mounted no higher than 48 inches and no lower than 15 inches above finished floor. [Subparagraph 2.02.B.2.a.1.c]				
3-4	Dimensions	Call stations shall be mounted with a flat surface in front of, and to the side of the units with a minimum dimension of 30 inches wide by 48 inches deep. The City prefers 60 inches wide by 60 inches deep. [Subparagraph 2.02.B.2.a.1.d]				
3-5	Braille	Braille must be included on the face of the call station, anywhere information is provided essential to the user (ex. “emergency button”). [Subparagraph 2.02.B.2.a.1.e] When Braille is used, it must have raised characters having their long dimension not less than 5/8”. [Subparagraph 2.02.B.2.a.1.e.1]				
3-6	Connect/ Disconnect Indicator	Call stations shall be equipped with a blue LED light that once either the emergency button or customer assistance button is pressed, the LED shall begin to flash, and once the call is picked up by the operator, the LED will turn to a solid (non-flash) light signal. [Subparagraph 2.02.B.2.a.1.f] The LED shall remain on in a non-flash mode until call is disconnected. [Subparagraph 2.02.B.2.a.1.f.1]				
Future Considerations						
4-1	Cellular	Cellular communications. [Subparagraph 2.02.D.1.b.3.a]				
4-2	Wireless	Wireless communications. [Subparagraph 2.02.D.1.b.3.a]				
Remote Diagnostics and Reporting Software						
5-1	Communications	Communication with call stations is achieved through existing phone line connections. [Subparagraph 2.02.D.1.e.1.a] System software does not require an additional data				

Item No.	Item	Description	C1	C2	NC	Comments
		network. [Subparagraph 2.02.D.1.e.1.b]				
5-2	Configurable Software	Diagnostics software shall have configurable parameters. [Subparagraph 2.02.D.1.d.1]				
5-3	Automatic Polling	System shall be capable of automatic poll (self-diagnostic) of all call station devices. [Subparagraph 2.02.D.1.d.5.a.1] Frequency of automatic polling shall be configurable. [Subparagraph 2.02.D.1.d.5.a.2]				
5-4	Manual Polling	System allows operator to initiate poll of any / all call station devices. [Subparagraph 2.02.D.1.d.5.b.1]				
5-5	Storage	System shall store diagnostic information for a preset period of time. [Subparagraph 2.02.D.1.d.3.a] Length of storage time shall be configurable. [Subparagraph 2.02.D.1.d.3.a.1]				
5-6	Automatic Alert	System shall alert the operator of any outage. [Subparagraph 2.02.D.1.d.4.a]				
5-7	Primary Equipment monitored	System can analyze all primary components of call stations for operation status. [Subparagraph 2.02.D.1.a.1.a.1].				
5-8	Auxiliary Equipment Monitored	System can analyze auxiliary components in which the call station is connected to, including the following [Subparagraph 2.02.D.1.a.1.b.1]: <ul style="list-style-type: none"> - Connection to camera - Connection to Phone switch - Connection to power - Connection to and operating conditions of strobe/beacon light (if vendor considers light to be auxiliary equipment) 				
5-9	Polling Reports	System automatically generates reports for pre-set and manual diagnostic polling and specifically identifies any failures. [Subparagraph 2.02.D.1.d.5.c.1]				
5-10	Ad-Hoc reporting	System has the ability to allow additional reports to be added through an ad-hoc report generating tool. [Subparagraph 2.02.D.1.d.7.a]				
5-11	Statistical Reports	System can generate reports over the previous 30 days of use on various statistical information including at least the following [Subparagraph 2.02.D.1.d.6.b]:				

Item No.	Item	Description	C1	C2	NC	Comments
		<ol style="list-style-type: none"> 1. Usage trends of call stations (emergency and customer assistance) by call station device and by area; 2. Duration of time between activation of call station (emergency or customer assistance) and phone pickup; 3. Queuing of call station calls; 4. Frequency of failures; and 5. Maintenance statistics. 				
5-12	System Logical Security	<p>With the new AVI system operating in an on-line real-time open architecture environment, adequate access and password management controls must exist in the AVI system to ensure proper segregation of duties, accountability, and system integrity. [Subparagraph 2.02.D.1.d.2.a] The following features shall be available:</p> <ol style="list-style-type: none"> 1. System uses both user ID and password to identify a specific user's access rights. 2. At least two levels of password security shall be provided for User and Administration levels; 3. System prevents duplicate user IDs; 4. System can lock or suspend users after a specified period of system inactivity and; 5. Password Management Controls. 				



Rev. No.	Rev. Date	RFC/CN/CO	Section(s) Affected	Comments
0	12/01/2017	N/A	All	First edition.
1	04/06/2018	N/A	2.03.A.4	Corrected address.



SECTION 16995

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for commissioning the electrical systems listed in Section 01810, Commissioning.
 - 2. Requirements for demonstrating the operation of the electrical systems listed in Section 01810, Commissioning, and the extent of the demonstration.
 - 3. Requirements for providing training to the Owner's personnel for the electrical systems listed in Section 01810, Commissioning, and the extent of the training.
- B. Related Requirements:
 - 1. Section 01330 - Submittal Procedures.
 - 2. Section 01360 - Sustainable Design Requirements.
 - 3. Section 01770 - Closeout Procedures.
 - 4. Section 01780 - Closeout Submittals.
 - 5. Section 01810 - Commissioning.
 - 6. Section 15950 - Testing, Adjusting and Balancing.
 - 7. Section 16080 - Electrical Testing.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. CA: Commissioning Authority.
 - 2. HVAC: Heating, Ventilating, and Air-Conditioning.
- B. Definitions:
 - 1. Commissioning: A systematic process to ensure that the Phoenix Sky Harbor International Airport's building systems perform interactively according to the design intent and operational needs of the Owner.
 - a. The commissioning process encompasses and coordinates the system documentation, equipment startup, control system calibration, testing and balancing, performance testing, and training.
 - 2. Commissioning Authority (CA): An independent agent engaged by the Phoenix Sky Harbor International Airport to direct and coordinate the commissioning process for the Project, and to approve the Work requiring commissioning.
 - a. The Commissioning Authority (CA) is not otherwise associated with the Design Consultant or the Contractor.



- b. The Commissioning Authority (CA) directs and coordinates the day-to-day commissioning activities without assuming oversight responsibilities.
 - c. The Commissioning Authority (CA) reports directly to the Program/Project Manager.
- 3. Commissioning Plan: An overall plan, developed before or after award of the Contract, that provides the structure, schedule, and coordination planning for the commissioning process.
- 4. Commissioning Team: A group of stakeholders that includes the following members who work together to fulfill contractual commissioning responsibilities under the Contract:
 - a. The Commissioning Authority (CA)
 - b. The Program/Project Manager.
 - c. The Facilities Manager (FM)
 - d. The Contractor.
 - e. The Contractor's Subcontractors whose equipment and systems will be commissioned, and who typically include the plumbing, HVAC, and fire suppression Subcontractors; the electrical and communications Subcontractors, the HVAC test and balance Subcontractor, the Building Automation System (BAS) Subcontractor, and other specialty system Subcontractors.
 - f. The Design Consultant.
- 5. Guaranteed Maximum Price (GMP): The sum of the maximum cost of the Work as defined in the Agreement, including the construction fee, costs of general conditions as defined in the Agreement, taxes, and the Contractor's contingency, including authorized adjustments.
 - a. ENVISION: The Envision sustainable infrastructure rating system is a comprehensive framework of 60 sustainability criteria that address the full range of environmental, social, and economic impacts to sustainability in project design, construction, and operation. These criteria—called “credits”—are arranged in five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. The full Envision guidance manual detailing the credits is provided at no cost to users.

C. Reference Standards:

- 1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. ASHRAE Guideline 1.1-2008 - HVAC&R Technical Requirements for the Commissioning Process (*Supersedes ASHRAE Guideline 1-1996*).
 - b. Institute for Sustainability Infrastructure (ISI)
 - 1) ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.



1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Commissioning requires participation not only of the Contractor, but also of the electrical Subcontractors and Suppliers, to ensure that systems are operating in a manner consistent with the requirements specified in the Contract Documents.
 - a. General commissioning and coordination requirements are specified in Section 01810, Commissioning.
 - 1) Familiarize the electrical Subcontractors with the requirements specified in Section 01810, Commissioning, and the Commissioning Plan issued by the Commissioning Authority.
 - 2) In each purchase order or subcontract written, include the requirements for submittal data, commissioning documentation, Operation and Maintenance data, and demonstration and training services required for performing commissioning activities.
2. Take responsibility for coordinating and scheduling the training specified in Section 01770, Closeout Procedures, and Section 01810, Commissioning; and ultimately for ensuring that the training is completed in accordance with the requirements specified.

B. Pre-Installation Meetings:

1. Commissioning Scoping Meeting:
 - a. Within 60 days of commencement of construction, the Commissioning Authority (CA) will schedule, plan, and conduct a Commissioning Scoping Meeting with the entire commissioning team for this Contract in attendance.
 - b. Information gathered from this meeting will allow the Commissioning Authority (CA) to update the Commissioning Plan to its "final" version, which will be distributed to all parties in attendance.
2. Miscellaneous Meetings:
 - a. Other meetings besides the Commissioning Scoping Meeting will be planned and conducted by the Commissioning Authority (CA) as construction progresses.
 - 1) These miscellaneous meetings will cover coordination, deficiency resolution, and planning issues with particular Subcontractors.
 - 2) The Commissioning Authority (CA) will plan these meetings, and will minimize unnecessary time being spent by Subcontractors.
 - 3) These miscellaneous meetings may be held monthly, until the final 3 months of construction when they may be held as frequently as one per week.
3. Meeting Minutes:
 - a. The Commissioning Authority (CA) will prepare and distribute meeting minutes to all parties in attendance at commissioning meetings.



1.04 SUBMITTALS

- A. Submit Product Data, Shop Drawing, and Operation and Maintenance Manual submittals of equipment to be commissioned to the Commissioning Authority as specified in Section 01810, Commissioning.
- B. Prior to submitting normal Operation and Maintenance Manual submittals, submit additional requested documentation to the Commissioning Authority to enable development of the startup and functional testing procedures.
 - 1. Submittal documentation includes, but is not limited to, detailed manufacturer installation and startup, operating, troubleshooting, and maintenance procedures; full details of Owner-contracted tests; fan and pump curves; full factory testing reports, if any; and warranty information, including clearly defined actions that are the responsibility of the Owner in order to keep warranties in force.
 - a. Include installation, startup, and checkout materials shipped with the equipment provided, and field checkout forms to be used by factory or field technicians.
 - b. The Commissioning Authority may request further documentation necessary for the commissioning process.
 - 2. Requests for data may be made prior to, concurrent with, or following normal submittals.
- C. Action Submittals:
 - 1. Submit the following to the Program/Project Manager for approval in accordance with the requirements of Section 01330, Submittal Procedures:
 - a. Special Procedure Submittals:
 - 1) Product Data, Shop Drawing, and Operation and Maintenance Manual submittals of equipment to be commissioned.
 - 2) Additional documentation requested by the Commissioning Authority.
- D. Closeout Submittals:
 - 1. Submit the following to the Program/Project Manager in accordance with the requirements of Section 01780, Closeout Submittals:
 - a. Record Documentation:
 - 1) Final computer-generated as-built drawings showing the commissioned electrical equipment and systems.

1.05 QUALITY ASSURANCE

- A. Sustainability Standards Certifications:
 - 1. The Phoenix Sky Train Project at the Phoenix Sky Harbor International Airport has been registered with the Institute for Sustainability Infrastructure (ISI) for the purpose of achieving the ISI's certification of the



Project under the ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.

2. The Project has been registered online under ENVISION Rating System For Sustainable Infrastructure - 2015 ISI, Inc.
3. In order to assist the Owner to qualify the Project for ENVISION certification, manage the ENVISION® prerequisites and credits related to commissioning that have been assigned to the Contractor, coordinate with the other assigned ENVISION® Project Team members to help them certify the various ENVISION™ requirements they are responsible for as indicated in Section 01360, Sustainable Design Requirements, and in other Contract Documents; and perform the Work of this Contract to deliver a product consistent with this goal.

1.06 WARRANTY

A. Manufacturer Warranties:

1. Determine the specific requirements necessary to maintain the validity of the warranties for electrical equipment and systems to be commissioned by contacting and coordinating activities with the manufacturers of the electrical equipment and systems to be commissioned and those responsible for actions required to maintain the warranties in effect.

B. Warranty Period:

1. During the warranty periods for the electrical equipment and systems to be commissioned, correct deficiencies and make necessary adjustments to the electrical equipment and systems, Operation and Maintenance Manuals, and Record Documentation.
 - a. Address applicable issues identified during seasonal testing.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 COMMISSIONING ELECTRICAL EQUIPMENT AND SYSTEMS

A. Electrical Subcontractors Commissioning Responsibilities:

1. The electrical Subcontractors, or the Contractor if there are no electrical Subcontractors, are required to execute the commissioning responsibilities assigned to them by the Contract Documents, including, but not limited to, the following:
 - a. Furnishing an itemized cost for providing the services to commission electrical systems for inclusion in the in the Guaranteed Maximum Price (GMP).



- b. Attending the commissioning scoping meeting and other meetings necessary to facilitate the commissioning process for this Contract.
- c. Supporting the Commissioning Authority (CA) through all phases of the commissioning process.
 - 1) The electrical Subcontractors are responsible for working with the Commissioning Authority according to the protocols established in the Commissioning Plan.
 - 2) The electrical Subcontractors are responsible for providing sufficient notice to the Commissioning Authority (CA) regarding the completion schedule for the pre-functional checklists and the startup of the electrical equipment and systems.
- d. Written Work Products:
 - 1) The electrical Subcontractors are responsible for furnishing the written work products specified in Section 01810, Commissioning, including the procedures to be executed as part of initial checkout and other input for developing the Startup Plans, and executed (filled in and signed) initial checkout, startup, and pre-functional checklists.
 - 2) If the Specifications, control drawings, or equipment documentation furnish insufficient information to allow detailed testing procedures to be written, then with assistance from the Program/Project Manager furnish clarification of the operation and control of the equipment to be commissioned to the Commissioning Authority (CA).
 - 3) Using the manufacturers' startup procedures and pre-functional checklists from the Commissioning Authority, develop initial checkout and full Startup Plans for electrical equipment and systems to be commissioned in accordance with the requirements specified in Section 01810, Commissioning.
 - a) Submit the initial checkout and full Startup Plans to the Commissioning Authority for review and approval prior to startup of the equipment or system.
 - 4) Provide assistance to the Commissioning Authority in preparing functional performance test procedures.
 - a) Review the test procedures to ensure their feasibility, safety, and protection of equipment; and furnish in writing the necessary alarm limits to be used during the tests.
- e. Furnishing the electrical testing equipment required to perform the commissioning procedures indicated in the Contract Documents.
- f. Executing the tasks listed on the approved pre-functional checklists and performing the startup tests.
 - 1) Provide skilled technicians to execute the starting of equipment.
 - a) Ensure that the technicians are available and present during agreed upon schedules, and for a sufficient time to complete the necessary tests, adjustments, and problem solving.



- g. Under the direction of the Commissioning Authority (CA), performing the functional performance tests (FPT), and executing seasonal or deferred functional performance testing, witnessed by the Commissioning Authority, in accordance with the Contract Documents.
 - 1) Provide skilled technicians to perform the functional performance testing under the direction of the Commissioning Authority for the equipment specified in Section 16080, Electrical Testing, and Section 01810, Commissioning.
 - 2) Assist the Commissioning Authority in interpreting monitoring data as necessary.
 - h. Correcting deficiencies, meaning differences between the specified and observed performance as interpreted by the Commissioning Authority, in the tested equipment and systems; and retesting the equipment and systems after corrections have been made.
- B. Electrical Equipment and Systems Supplier's Commissioning Responsibilities:
 - 1. The electrical Suppliers and vendors are required to execute the commissioning responsibilities assigned to them by the Contract Documents, including, but not limited to, the following:
 - a. Furnishing requested Submittal data, including detailed startup procedures, and specifying specific responsibilities of the Owner required for maintaining the equipment warranties in force.
 - b. Furnishing assistance during equipment testing.
 - c. Furnishing costs to include in the Guaranteed Maximum Price (GMP) for special tools and instruments only available from the equipment Suppliers or vendors, that are specific to a piece of equipment, as required by the Specifications, and required for testing the equipment according to the Contract Documents, except for stand-alone data logging equipment that may be used by the Commissioning Authority (CA).
 - d. Furnishing information requested by the Commissioning Authority (CA) regarding the sequences of operation and testing procedures for equipment.
 - e. Reviewing and approving test procedures for equipment installed by factory representatives.

3.02 SYSTEM STARTUP

- A. Prior to system startup, complete the electrical systems and sub-systems so the systems and sub-systems are fully functional, and meet the performance and design requirements of the Contract Documents.
 - 1. Commissioning procedures and functional testing do not relieve or lessen this responsibility, or shift this responsibility in whole or in part to the Commissioning Authority or the Owner.
 - 2. Address current punch list items before performing functional testing.



- a. Complete air and water testing and balancing, and remedy discrepancies and problems discovered, before performing functional testing of air-related or water-related electrical systems.
 - 1) Testing, adjust, and balance heating, ventilating, and air-conditioning (HVAC) systems in accordance with the requirements specified in Section 15950, Testing, Adjusting and Balancing.
- B. Initial Checkout Process and Startup:
 - 1. The electrical Subcontractors are responsible for following the startup and initial checkout procedures specified in Section 01810, Commissioning, for electrical equipment and systems provided under this Contract.
 - a. During initial checkout process and startup, execute and document the electrical-related portions of the pre-functional checklists provided by the Commissioning Authority for commissioned equipment and systems.
 - b. Perform and clearly document completed startup and system operational checkout procedures, and submit a copy to the Commissioning Authority.
- C. Functional Testing:
 - 1. A complete list of systems to be commissioned, and a description of the process is specified in Section 01810, Commissioning.
 - a. Have the Commissioning Authority (CA) at a minimum perform the startup and checkout activities listed in Section 01810, Commissioning, for the sweep or scheduled lighting controls, daylight dimming controls, lighting occupancy sensors, power quality, security systems, emergency power systems, uninterruptible power supply (UPS) systems, fire and smoke alarms, fire protection systems, communications systems, public address/paging, variable frequency drives, and building automation system work pertinent to the Work of this Section.
 - b. Specific details of the required functional performance tests are specified in Section 16080, Electrical Testing.
 - c. Specific details regarding non-conformance issues relating to pre-functional checklists and tests are specified in Section 01810, Commissioning.
 - 2. Begin functional testing of each electrical equipment item or system when the equipment item or system is completed.
 - a. At the discretion of the Commissioning Authority (CA) and the Program/Project Manager, functional testing may proceed prior to completion of the system or sub-systems.
 - b. Beginning testing of a system before it is completed does not relieve the Contractor from fully completing the system, or executing pre-functional checklists, as early as possible.
 - c. Specific details regarding deferred testing are specified in Section 01810, Commissioning.



3.03 CLOSEOUT ACTIVITIES

- A. The Commissioning Authority is responsible for overseeing and approving the content and adequacy of the training provided to the Owner's personnel for commissioned electrical equipment and systems.
- B. Electrical Subcontractors:
 - 1. The electrical Subcontractors are responsible for performing the following training-related functions after the functional testing is complete, unless otherwise approved by the Owner in writing:
 - a. For each major piece of equipment, engage an appropriate expert and qualified trainer to furnish the instruction for the Owner's operating staff and demonstrate the equipment as specified.
 - 1) The trainer may be the startup technician for the piece of equipment, the installing Subcontractor, or a trade or manufacturer's representative.
 - 2) The trainer must possess practical building operating expertise and in-depth knowledge of the specific piece of equipment's modes of operation.
 - 3) More than 1 trainer may be required to demonstrate or furnish training for a piece of equipment.
 - b. At least 2 weeks before the training and demonstration are scheduled to occur, submit an outline describing the training to be furnished as specified in Section 01810, Commissioning.
 - c. For each electrical system, subsystem, or piece of equipment to be commissioned, provide the Owner's designated personnel with a comprehensive orientation and a training session, or training sessions, designed to furnish an understanding of the systems and their operation and maintenance as specified in Section 01770, Closeout Procedures.
 - 1) Begin the training with classroom sessions, if necessary, followed by hands-on training on each piece of equipment or system designed to illustrate the equipment's or system's various modes of operation, including startup, shutdown, fire or smoke alarm, power failure, and similar modes.
- C. Demonstration:
 - 1. Engage the electrical Subcontractor to fully explain and demonstrate the operation, function, and overrides of local packaged controls not controlled by the central control system to the Owner's designated personnel.
 - a. During the demonstration, if the system fails to perform in accordance with the requirements of the Operation and Maintenance Manual or the sequence of operations, repair or adjust the system as necessary, and repeat the demonstration.
- D. Training of Owner Personnel:



1. Duration of Training:
 - a. Furnish training lasting as long as specified in Section 01770, Closeout Procedures.
 2. Classroom Sessions:
 - a. Design training sessions to follow the Table of Contents of the Operation and Maintenance Manuals for the subject equipment, and whenever possible illustrate the use of the Operation and Maintenance Manuals for reference.
 - 1) Use the format and training agenda included in ASHRAE Guideline 1.1-2008.
 - 2) Use overhead projections, slides, video/audio-taped material, as appropriate, in classroom sessions.
 - 3) Refer to the printed installation, operation, and maintenance instruction material included in the Operation and Maintenance Manual for the equipment or system.
 - 4) Review the written operation and maintenance instructions, emphasizing safe and proper operating requirements, preventative maintenance, special tools needed, and spare parts inventory suggestions.
 - 5) Teach students the startup, shutdown, seasonal changeover, and emergency procedures as applicable, and operation of the equipment or system in all possible modes.
 - 6) Discuss relevant health and safety issues and concerns.
 - 7) Discuss warranties and guarantees.
 - 8) Describe common troubleshooting problems and solutions.
 - 9) Discuss peculiarities of the equipment installation or operation.
 - 10) Discuss the explanatory information included in the Operation and Maintenance Manuals, and the location of plans and manuals in the facility.
 3. Hands-On Training
 - a. Furnish hands-on training that includes startup and operation in all modes, including, but not limited to, manual operation, shut-down, and emergency operation procedures, if any.
 - b. Furnish hands-on maintenance training for each piece of equipment.
- E. Record Documentation
1. During construction, prepare and maintain as-built red-line drawings on Contract Drawings, and prepare final computer-generated as-built drawings to be used as coordination drawings.
 2. Update the as-built drawings after completion of the commissioning activities, excluding the deferred functional testing.
 3. Submit the final computer-generated as-built drawings showing the commissioned electrical equipment and systems to the Program/Project Manager.



3.04 MAINTENANCE

A. Operation and Maintenance Manuals:

1. Prepare Operation and Maintenance Manuals in accordance with the requirements specified in the Contract Documents.
 - a. The electrical Subcontractors and equipment Suppliers are responsible for compiling and preparing documentation for the electrical equipment and systems provided under this Contract for inclusion in the Operation and Maintenance Manuals.
2. Submit a copy of the Operation and Maintenance Manuals and submittals for the electrical equipment and systems to be commissioned, as specified in the Contract Documents, to the Commissioning Authority for review.
3. The electrical Subcontractors are responsible for clarifying and updating the original sequences of operation furnished to as-built conditions.

END OF SECTION

REV. NO.	REV. DATE	RFC/CN/CO	Section(s) Affected	Comments
0	10/06/2017	N/A	All	First edition.
1	12/20/2017	N/A	1K.02.A.5, 1.02.C.18, 2.10.B.2	Add requirements for ENVISION Sustainability Rating System

